

National Senior Certificate

2020

DIAGNOSTIC REPORT
PART 3: TECHNOLOGY SUBJECTS



basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA



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Foreword from the Minister

At the heart of a successful education system, is a credible public examination system built on the foundations and pillars of integrity. It must enjoy respect and be acknowledged as such by higher education institutions, employers and our people. The National Senior Certificate has stood the test of time and after 12 years of teaching and learning, this qualification has intrinsic value for both individuals and society.

The year 2020 will go down in history as one in which we faced unprecedented challenges that affected every facet of human life. The Class of 2020 sat for the National Senior Certificate (NSC) examinations in a year that the world was held to ransom by the Covid-19 pandemic. When this cohort commenced with their exit year of the NSC, no one would have imagined the challenges that they faced.

The pandemic did not derail the Department of Basic Education and Public Examinations from its primary objective to deliver quality education and credible examinations. In 2020, our aim was to rescue the education sector from ruins that this virulent pandemic has caused. We have taken extraordinary measures to combat and manage the spread of the epidemic in our sector. We adopted a staggered approach for the re-opening of schools to avoid congestion and observe the novel social distancing. Our strategy to rescue the 2020 academic year is predicated on curriculum trimming for all grades, except Grade 12. The full curriculum coverage for Grade 12s aims to ensure that the exit qualification of the Class of 2020 enjoys the same status as the previous cohorts.



Although the Class of 2020 did not attain a better pass rate than the Class of 2019, it must be acknowledged that despite a very difficult year, this cohort exceeded expectations. If the achievements of different cohorts over the past decade are considered, it is evident that the standard and quality of the public examinations system is stabilising. The proficiency of our education system is confirmed by the fact that the achievements in gateway subjects have been on par over the past five years.

The 2020 *National Diagnostic Report on Learner Performance* serves as an all-inclusive study and detailed analysis of candidates' performance in the NSC examinations. This report is in its tenth year of publication. Initially, the report only focused in the gateway subjects but since 2018 diagnostic reports are also offered in home languages, technologies and technical subjects. This year we also include reports for Afrikaans First Additional Language and Engineering Graphics and Design (EGD). This Diagnostic Report provides teachers, subject advisors, curriculum planners and social partners with insight into learners' performance in the targeted subjects.

This diagnostic report is therefore presented in three parts. Part 1 comprises the diagnostic reports of the ten gateway subjects. Part 2 contains the diagnostic reports for English First Additional

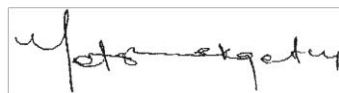
Language, the twelve home languages and Afrikaans First Additional Language. Part 3 includes the diagnostic reports for technical subjects, technologies and EGD. In the 2020 report, a detailed per-question analysis of learners' responses is given for each of the 10 high enrolment subjects: Accounting, Agricultural Sciences, Business Studies, Economics, Geography, History, Life Sciences, Mathematics, Mathematical Literacy and Physical Sciences. In Part 2 of this publication, a detailed per-question analysis and qualitative analysis of learners' responses are given for English First Additional Language. A detailed qualitative analysis of learners' responses to questions is given for each of the home languages in Part 2 and Part 3 for each of the technical subjects and technologies.

One of the key objectives of the diagnostic report is to improve the quality of teaching and learning. The quantitative and qualitative analysis of learner performance in the November 2020 examinations serves to identify the strengths and weakness in candidates' knowledge and skills. In response to weaknesses identified, the report further suggests remedial measures that should be adopted at school level. This will allow teachers to identify the problem areas hindering effective teaching and learning, identifying the knowledge gaps and refining teaching strategies accordingly, and considering information or approaches that can be integrated into teaching reform and academic improvement plans in the new academic year.

It is imperative that a diagnostic analysis is done of learners' performance by teachers after the completion of each assessment task. The outcome of an analysis of the performance of learners in informal and formal assessment tasks can serve to devise intervention strategies to improve learners' understanding of subject matter. Teacher mediation of a diagnostic analysis of

performance is a pivotal component in addressing gaps in learning.

The efforts invested into the Class of 2020 culminated in their achievements. I am confident that, despite the myriad of challenges posed by the Covid-19 pandemic, the DBE and all its warriors in education, will, through effective interventions, such as this diagnostic report, achieve a positive impact on learner performance in 2021. The Xitsonga saying, 'Dyondzo I xitlhangu xa vutomi' is forever true. Roughly translated, 'Education is the shield of life'. I therefore invite all education stakeholders and the broader South African public to get involved in the DBE's efforts to fight the battle to improve lives and livelihoods through quality basic education.



MRS AM MOTSHEKGA, MP
MINISTER OF BASIC EDUCATION
22 FEBRUARY 2021



CHAPTER 1

INTRODUCTION

1.1. INTRODUCTION, SCOPE AND PURPOSE

The Class of 2020 is the seventh cohort to sit for the NSC examinations based on the CAPS. In line with past reports, the 2020 Diagnostic Report illuminates key observations in learner performance. One of the primary objectives of this report is to serve as a teaching and learning resource tool 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. It is essential that the 2020 diagnostic report should be used in conjunction with the 2015 to 2019 diagnostic reports. Key subject didactic principles and content matters addressed in past reports, along with the revised Annual Teaching Plans, can be used fruitfully in the classroom in 2021.

Post the marking process, the chief markers, internal moderators and subject specialists compiled subject reports that outline qualitative data. This diagnostic report is based on this data. In the ten key subjects and English First Additional Language, quantitative data was also gathered from the analysis of 100 scripts per paper, per subject, randomly selected from each province. This qualitative and quantitative data highlight the areas of weakness in each of the identified subjects and articulate the remedial measures to be adopted at school level to improve performance in these subjects. As a result, this National Diagnostic Report on Learner Performance provides teachers, subject advisors, curriculum planners and curriculum implementers with a picture of learner performance in each of the key subjects.

Each subject's diagnostic report commences by presenting comparative data on the performance trends observed over a five-year period in the subject, from 2016 to 2020. In the ten key subjects and English First Additional Language, 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.

In 2020 it was observed, once again, that the poor quality of answers provided by some candidates in certain subjects suggest gaps in the scope of content coverage and teaching methodology. The Covid pandemic exacerbated the poor performance of the learners, as the gaps widened, particularly for learners who had no access to schooling during this period. Given this, attempts have been made to track progress made in the subject and in content areas which were highlighted as problematic in previous years. It is these recurrent areas of weakness that must become the baseline for intervention by the Subject Advisory Services in the new academic year. Progress or lack thereof, in the said areas, should determine the extent to which further interventions are necessary in 2021. 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.

Given that this report is a key teaching and learning resource, the aim is that it will be used effectively by every Grade 12 teacher and subject advisor in 2021. Subject advisors are encouraged to mediate this key resource in their workshops with teachers in the new academic year. It is envisaged that subject-based diagnostic analysis will be institutionalised within the pedagogical practice not only at national level, but also at provincial, district and school levels.

The DBE and Provincial Education Departments (PEDs) will monitor the distribution and utilisation of this report and feedback from teachers and subject advisors on the usefulness of these reports.

1.2. METHODOLOGY

In the 10 high enrolment subjects and English First Additional Language, 100 scripts per question paper were randomly selected from each province during the marking. These scripts included samples of low, medium and high achievement scores.

The internal moderators and chief markers analysed and noted learners' responses to each question. This entailed recording the marks obtained by learners 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. Attention was given to common errors and misconceptions identified in the learners' responses.

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

Section 1: Performance trends (2016 – 2020)

A comparative analysis of the performance of learners over the last five years in terms of the number of learners who wrote, the number and percentage of learners who achieved at 30% and above, and the number and percentage of learners who achieved at 40% and above, is presented in this section. The information is represented by tables and graphs to enable easier interpretation of any trends, especially 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 learner scores in the last three examinations. Any improvement or decline in the performance can be observed from the position of the 2019 graph, relative to previous years. If the 2020 graph lies to the right of the two previous graphs, this suggests an improvement in performance, while a slant to the left indicates a decline in performance.

Section 2: Overview of learner performance

This section summarises the performance of learners in the question paper as a whole. It refers to generic areas of good performance or weakness and the possible reasons for these observations.

Section 3: Diagnostic question analysis

This includes the following:

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

The internal moderators' reports from all nine provinces for each question paper, per subject were consolidated and the findings are summarised in this report. It is recommended that this report be read in conjunction with the November 2020 NSC question papers since references are made to specific questions, in the respective question paper, in each subject. This will enable teachers to establish a baseline for the new cohort of Grade 12 learners in 2021; develop strategies for differentiated learning and provide a frame of reference for the development and design of school-based assessment during the year.

1.3. LIMITATIONS

The focus of this report is more qualitative than quantitative. The quantitative aspects are limited to the performance trends in each subject and the average performance per question in the 2020 examination papers. While further quantitative data would have been useful in providing feedback for test development, this is not the intention of this report.

This report therefore provides a national summary of the areas of weakness. District specialists should not only refer to the provincial report but must be 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.

The diagnostic analysis of learner performance in this publication is only limited to the ten subjects with high Grade 12 enrolments, 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.

1.4. GENERAL FINDINGS AND AREAS OF CONCERN

The 2020 diagnostic reports for the ten key subjects covered in this publication (Part 1), indicate that the pass rate has improved in three of these subjects (Business Studies, History and Mathematical Literacy) 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 six home languages (Afrikaans, English, IsiNdebele, Sepedi, SiSwati, SASL HL), remained the same in Setswana and Tshivenda and declined to varying degrees in four home languages (isiXhosa, isiZulu, Sesotho and Xitsonga).

After seven years of the implementation of the Curriculum and Assessment Policy Statement (CAPS) in Grade 12 the standard and quality of the NSC examinations, based on CAPS, is considered to be stabilising.

It is imperative that we reflect on and learn from the performance of candidates of the 2020 NSC examinations.

The following areas of concern were identified in past diagnostic reports and they are, once again, highlighted as concerns in the 2020 NSC examinations.

- There was a general observation that not all topics were equally covered in preparation for examinations. This was particularly noticeable in centres where learners had no access to schooling during the lockdown and extended school holidays in 2020. It is essential that all prescribed topics in CAPS are studied and that there is adherence to the examination guidelines.
- In the languages, it was noticed that candidates were not familiar with the formats of 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 a school newspapers and allow learners to write articles etc.
- In most home languages, most candidates either misinterpreted or gave limited responses to higher order questions in Paper 1 and Paper 2. There is therefore a need to enhance thinking in an abstract context in languages. Challenging topics need to be included in classroom and homework exercises to allow learners to get accustomed to employing critical language skills to think analytically and critically.
- Schools are encouraged to initiate reading projects/reading periods/vocabulary/dictionary exercises to expand learners' vocabulary. In 2020, it was noted that many candidates did not understand the vocabulary used in questions, extracts and comprehension texts. 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.

- SASL HL, Technical Sciences, Technical Mathematics and the Technologies were offered for the fourth year in the Grade 12 NSC examinations. It can be deduced from candidates' responses that focused intervention strategies need to be initiated and implemented to ensure that candidates have a solid understanding of the topics in new subjects. In SASL HL, 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 familiarised with the register, style and conventions for transactional writing texts.
- A large percentage of candidates displayed a limited understanding of subject matter, and specifically complicated topics. This was exacerbated by the lack of access to on-site teaching during the lockdown period. The diagnostic report is geared towards addressing these concerns.
- Although candidates performed well in questions that required lower order thinking skills, many learners 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.

1.5. KEY RECOMMENDATIONS

1.5.1 Diagnostic reports from 2015 to 2020

The diagnostic reports published from 2015 to 2020 are pertinent to gain a holistic grasp of learners' 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. Part 1, Part 2 and Part 3 must be used in preparing the Class of 2021 for the NSC examinations.

1.5.2 Past question papers

Teachers are discouraged from teaching to the paper. However, past question papers should be used as a teaching and learning resource. A question paper serves 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.

1.5.3 Language in teaching

It must be stressed that language across the curriculum is a central part of the learning experience. Teachers across all subjects are encouraged to work collaboratively to integrate a school-based language strategy that aims to improve learner performance. The language classroom is not the only context where learners can improve their language skills. 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:

- There needs to be greater emphasis on aspects of language competence and examination technique. Candidates often respond appropriately to questions but inadequate language skills and a solid understanding of examination techniques impact negatively in their performance.
- 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.
- Language and comprehension skills must be developed in each classroom, across subjects.

1.5.4 Integrated intervention strategies

As the 2021 cohort of Grade 12s had an interrupted Grade 11 year in 2020, it is imperative that 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 the learners with the topics to be covered during the year and the relevant websites, per topic.
- 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, 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. This is particularly important as the pandemic has highlighted the great divide between those who have online access and those who do not.
- Teachers from different schools in each circuit or district could collaborate to support one another in mediating challenging topics to learners.
- Challenging topics must be revisited regularly during the academic year, through extension activities and they should form the basis of all extra classes. Stronger candidates can be paired with weaker candidates to complete assignments on challenging topics.

- Online study groups could be formed to facilitate revision activities and examination preparations through platforms such as Microsoft Teams.
- Teachers from different schools can build an item bank of higher order questions and this bank can be used as a resource for revision purposes.

1.6. RESPONSIBILITIES

1.6.1 Provincial Education Departments

- Given that the target audience of this report include 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 do a baseline assessment of the 2021 Grade 12 cohort, to establish the impact that the pandemic had on teaching and learning during 2021, in terms of Grade 11 content coverage.
- It is also important that subject advisers emphasise that the Revised Annual Teaching Plan reflects the minimum requirements of the subject.
- Subject advisers are encouraged to convene meetings/workshops (on online platforms or in groups that adhere to Covid-19 protocol) that aim to mediate this diagnostic report. It is further suggested that the use of this diagnostic report must encouraged during on-site support visits.
- Subject advisers should also monitor the improvement plans of their teachers, 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

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

CHAPTER 2

TECHNICAL MATHEMATICS

The following report should be read in conjunction with the Technical Mathematics question papers of the November 2020 examination.

2.1 PERFORMANCE TRENDS (2018 – 2020)

In 2020, 10 731 learners sat for the Technical Mathematics examination. The performance at 30% and above was 32,4%, representing a decline of 10,3% from 2019. The continued decline in performance is cause for concern.

Table 2.1.1 Overall achievement rates in Technical Mathematics

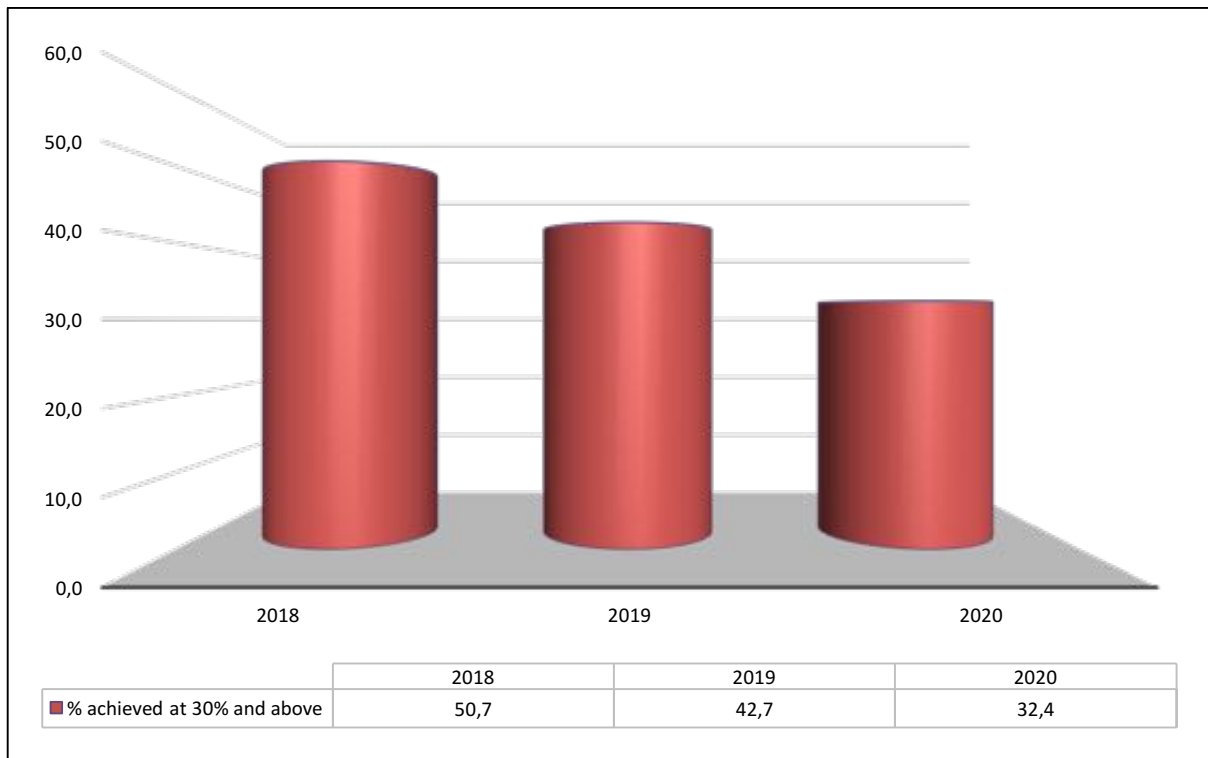
Year	No. wrote	No. achieved at 30% and above	% achieved at 30% and above
2018	10 025	5 078	50,7
2019	9 670	4 125	42,7
2020	10 731	3 476	32,4

The 2020 candidates were the third cohort to sit the Technical Mathematics examinations. The subject is still fairly new and many teachers are still trying to cope with the demands of the subject. This has an impact on candidates' performance.

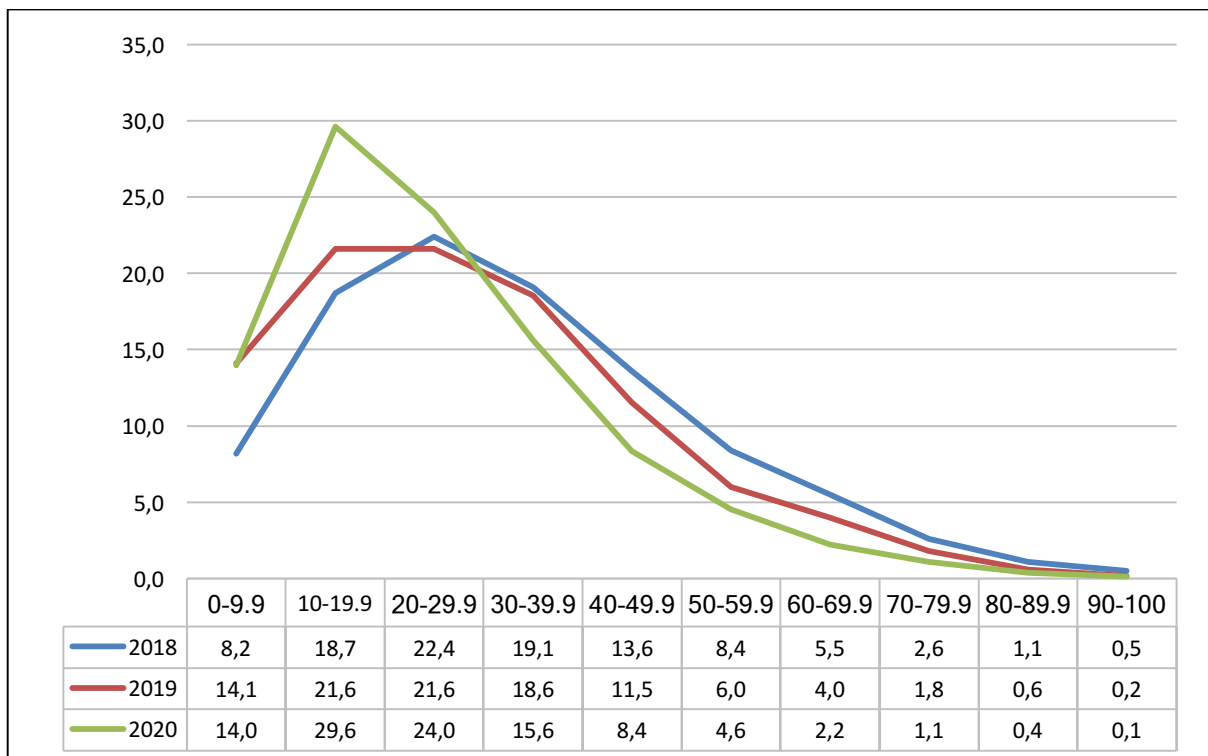
However, candidates' inability to perform elementary arithmetical calculations is a concern. Revision of work from earlier grades will play an integral part in improving performance in the subject. There is still room for improvement in the performance of candidates if the challenges surrounding mathematical 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 that '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.

Graph 2.1.1 Overall achievement rates in Technical Mathematics (percentage)



Graph 2.1.2 Performance distribution curves in Technical Mathematics (percentage)



2.2 OVERVIEW OF LEARNER PERFORMANCE IN PAPER 1

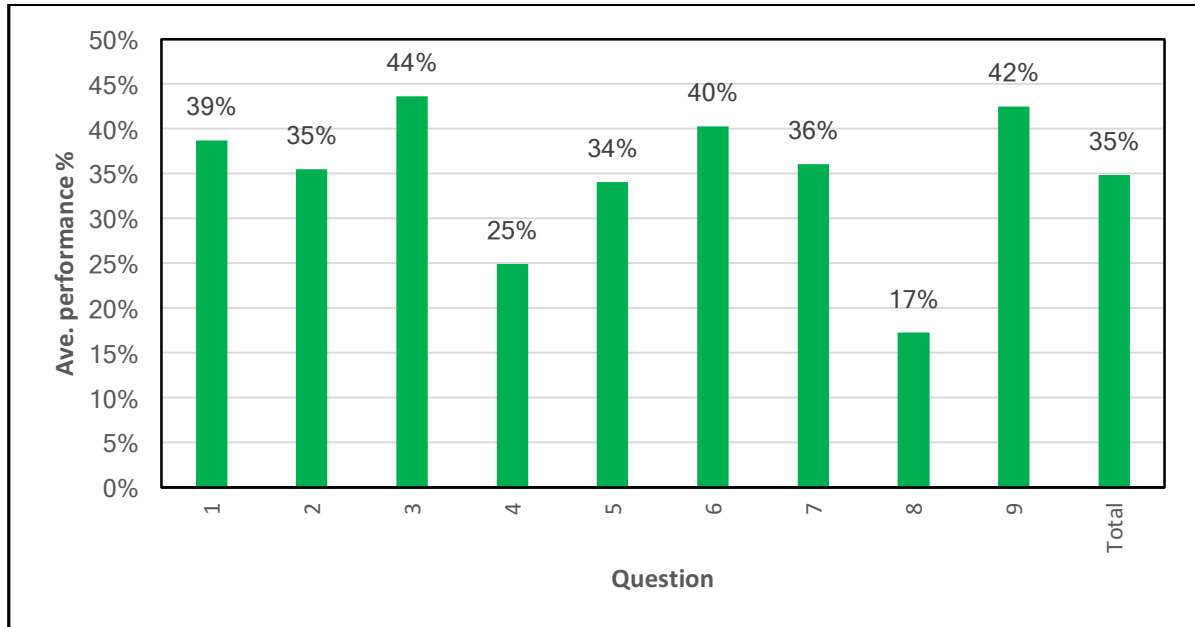
General comments

- (a) Candidates performed relatively well in Q3, Q6 and Q9 as compared to 2019. The topics covered in these questions were Exponents, Surd, Logs and Complex Numbers, Differential Calculus and Integration.
- (b) The best performed subquestions involved the solving of simultaneous equations, subject of the formula, finding the discriminant, simplification of exponents, surds and logs, calculating the derivative using first principles and calculating the intercepts of cubic functions and indefinite integrals.
- (c) Candidates performed well in Q1, Q2, Q5 and Q7 where Equations and Inequalities, Nature of Roots, Finance Growth and Decay and Cubic Functions were assessed. There has been an improvement of performance in Nature of Roots and Finance, Growth and decay in comparison to 2019.
- (d) Candidates performed poorly in the following topics: Functions and Graphs and Optimisation, covered in Q4 and Q8. Candidates performed very poorly in questions involving applications and modelling.
- (e) Performance in topics taught in earlier grades was poor in comparison to performance in topics done in Grade 12. This was probably due to inadequate time being allocated for revision of work from the earlier grades.
- (f) Higher-order questions such as the interpretation of graphs as well as measurement and mensuration were either not answered or poorly answered. Questions in which topics were integrated proved to be challenging for many candidates.
- (g) Candidates did not adhere to the instructions as stipulated in the question paper.

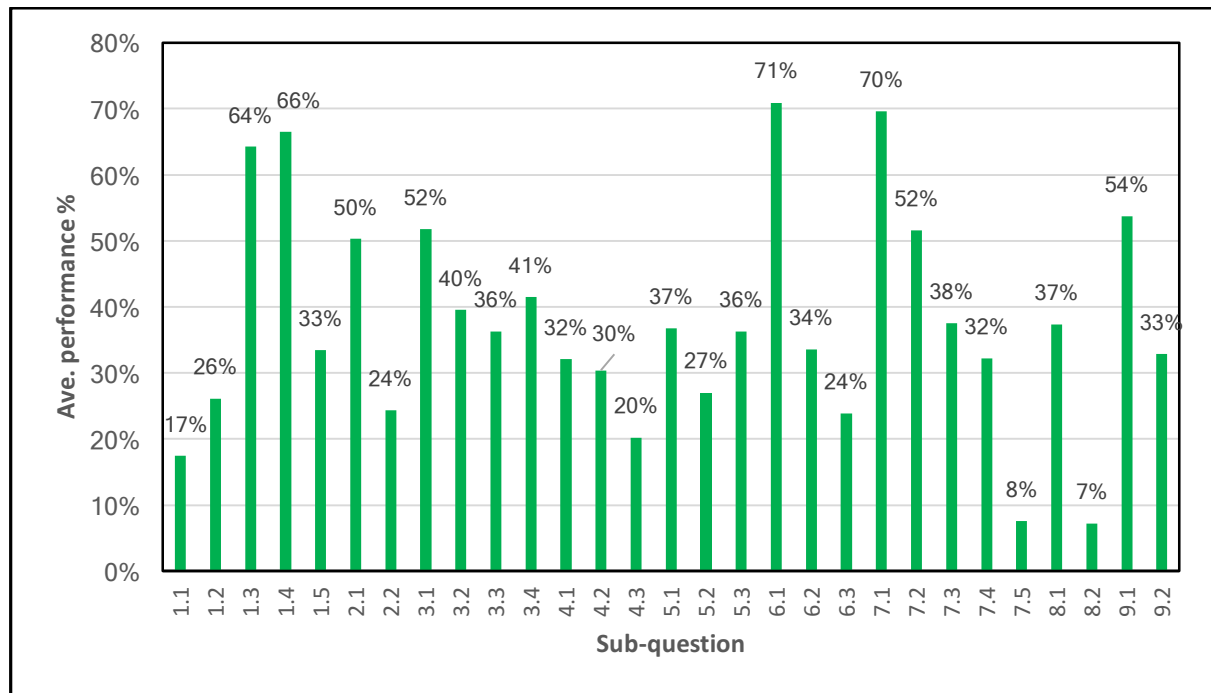
2.3 DIAGNOSTIC QUESTION ANALYSIS OF PAPER 1

The following graph is based on data from a random sample of candidates. 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/s
1	Equations and Inequalities
2	Nature of Roots
3	Exponents, Surds, Logarithms and Complex numbers
4	Functions and Graphs
5	Finance, Growth and Decay
6	Differential Calculus
7	Differential Calculus-Cubic functions
8	Differential Calculus-Optimization
9	Integration

Graph 2.3.2 Average performance per sub-question in Paper 1


Sub-question	Topic/s
1.1	Length, breadth and area
1.2	Equations and inequalities
1.3	Simultaneous equations
1.4	Subject of the formula and substitution
1.5	Binary numbers
2.1	Nature of roots
2.2	Nature of roots
3.1	Exponents and Surds and Logarithms
3.2	Logarithms
3.3	Complex numbers
3.4	Equations with complex numbers
4.1	Semi-circle and linear graph
4.2	Hyperbola
4.3	Parabola

Sub-question	Topic/s
5.1	Loan and effective interest rate
5.2	Depreciation
5.3	Investment
6.1	First Principles
6.2	Differentiation rules
6.3	Tangent line
7.1	Cubic: y-intercept
7.2	Cubic: x-intercept
7.3	Cubic: Turning points
7.4	Cubic graph
7.5	Interpretation of graphs
8.1	Calculus of motion
8.2	Calculus: Surface area and Volume
9.1	Indefinite Integrals
9.2	Integration: Area

2.4 ANALYSIS OF LEARNER PERFORMANCE IN EACH QUESTION IN PAPER 1

QUESTION 1: EQUATIONS AND INEQUALITIES (ALGEBRA)

Common errors and misconceptions

- (a) In Q1.1.1(a) candidates did not realise that the outside length of the rectangular board was $2x$ metres longer than the length given in the area of the poster.

In Q1.1.1(b) candidates did not realise that the outside breadth of the rectangular board was $2x$ metres longer than the breadth given in the area of the poster.
- (b) Most candidates failed to show that $A = 4x^2 + 30x + 36$ by using the formula: Area = length \times breadth, given in Q1.1.2. This question was dependent on Q1.1.1(a) and Q1.1.1(b). Since candidates were unable to write the length and breadth in terms of x as required, they were unable to write the area in terms of x .
- (c) Many candidates were unable to interpret Q1.1.3. As a result, they equated $4x^2 + 30x + 36$ to 0 instead of 52. Candidates who managed to interpret the question correctly, solved for x and got $x = \frac{1}{2}$ or $x = -8$ but did not reject $x = -8$. They did not realise that the length cannot be negative.
- (d) In Q1.2.1 candidates could not manipulate the fraction and write the equation in standard quadratic form. Some candidates wrote $3x^{-1} - 7x + 5 = 0$.
- (e) Most candidates did not realise that, in Q1.2.2, x^2 will always be non-negative for any value of x . Therefore, they solved the equation using algebraic methods by transposing 4 to the RHS and found $\sqrt{-4}$ and concluded that the roots are non-real or do not exist.
- (f) In Q1.3 candidates were unable to square a binomial, simplify correctly and then determine the correct standard form.
- (g) When making f the subject of the formula in Q1.4.1, most candidates divided X_c by $2\pi C$ and did not realise that they were left with $\frac{1}{f}$ on the RHS.
- (h) In Q1.5.1 many candidates failed to add the binary numbers and few omitted the base 2.
- (i) In Q1.5.2 some candidates were unable to convert a binary number to a decimal number.

Suggestions for improvement

- (a) Teachers should expose learners to modelling and or problem-solving type questions during teaching and learning and provide them with a variety of examples to answer. Technical Mathematics learners should be exposed to different forms of real-life technical problems.

- (b) Regular revision of topics done in earlier grades, e.g. simplification of fractions, factorisation, products and solution of simultaneous equations, is strongly suggested.
- (c) Integration of topics is vital. Teachers should integrate Algebra with Functions so that learners have a visual understanding of the region of the graph that is applicable to the given situation, especially when it comes to 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.
- (d) Basic operations including addition, multiplication, subtraction and division involving binary numbers and the conversion from one number system to the other should be revised in Grade 12. Emphasise the writing of the correct notation, i.e. for binary numbers the base 2 should be indicated. Teachers should inform learners that the base for the decimal number system is 10 and that we use the decimal number system more than any of the other number systems. It is not necessary to write the base 10 each time one writes a decimal number. If there is no base indicated for a number, it is assumed that it is a decimal number.

QUESTION 2: NATURE OF ROOTS

Common errors and misconceptions

- (a) In Q2.1.1 some candidates were unable to identify the values of a , b and c .
- (b) Some candidates failed to state the nature of roots satisfying the given or calculated discriminant. Since the discriminant was negative, some concluded that there is no solution in Q2.1.2.
- (c) In Q2.2.2 many candidates omitted p when they were substituting into the discriminant. Some candidates did not realise that for roots to be rational the discriminant should be a perfect square.

Suggestions for improvement

- (a) Teachers should show 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 $x = \frac{-b \pm \sqrt{\Delta}}{2a}$. The value that appears under the radical sign determines the nature of the roots of the equation. By integrating the topics of functions and nature of roots, teachers can explain to learners that *non-real roots* and *no solution* are different concepts.
- (b) Learners should be exposed to application involving the nature of roots. Examples should include 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 many candidates could not apply the laws of exponents. They cancelled $\log 3$ before factorisation or simplification.

- (b) Many candidates had difficulty in writing the surd in Q3.1.2 in simplified form. This would have enabled them to simplify the expression. Also, they were unable to convert from surd form to exponential form and apply exponential rules.
- (c) In Q3.2 some candidates failed to convert the log form into an exponential form.
- (d) Many candidates did not realise that a complex number can have only the imaginary part, as given in Q3.3.1 and Q3.3.2. They failed to get the correct value of r and subsequently the size of θ .
- (e) In Q3.4 some candidates failed to apply the principle of BODMAS. Further, they did not write the value of k and m as required. Instead, they left the equation at the simplification step.

Suggestions for improvement

- (a) Learners should revise all exponential, surd and logarithmic laws done in earlier grades.
- (b) Teachers need to 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 the graphical representation of complex numbers. Learners should be taught how to write a complex number in its polar form and plot in an Argand diagram. Teachers must ensure that learners adhere to the given instructions.

QUESTION 4: FUNCTIONS

Common errors and misconceptions

- (a) In Q4.1.1 some candidates simplified $4\frac{1}{2}$ to 2.
- (b) Most candidates had difficulty in reading the domain from the graph and writing it in the correct notation.
- (c) In Q4.2 many candidates could not sketch the function using the given properties.
- (d) In Q4.3.1 and Q4.3.2 some candidates struggled with the interpretation of graphs.
- (e) Some candidates were unable to determine the equation of the parabola in Q4.3.2 and therefore could not write down the values of a and b .
- (f) In Q4.3.3 candidates did not realise that the x -coordinate of R was the same as the given point V.
- (g) Candidates did not know how to respond to Q4.3.4, a question in which the instruction read: 'Show that ...'.
- (h) In Q4.3.6 the interpretation of graphs posed a challenge for many candidates. They did not understand what was required of them.

Suggestions for improvement

- (a) Learners should revise the basic number operations and the manipulation of fractions.
- (b) Teachers should explain the meaning of inequalities and the definition and correct notation of the domain and range of a function.
- (c) Properties of graphs should be thoroughly explained and demonstrated to learners.
- (d) Teachers should expose learners to different ways of determining the equations of the parabola.
- (e) It needs to be explained to learners that when the question states 'Show/Prove that ...', it means calculate (justify by means of correct mathematics) what is given, and the final answer reached must match what is stated in the question.
- (f) Teachers should expose learners to questions involving two graphs on one system of axes - not only the drawing of graphs but the interpretation as well.

QUESTION 5: FINANCE, GROWTH AND DECAY

Common errors and misconceptions

- (a) When calculating the amount of the loan in Q5.1.1, many candidates did not subtract the 10% deposit from the value of the new car.
- (b) Some candidates failed to write the correct formula in Q5.1.2. Other candidates did not divide the rate by 12.
- (c) Many candidates had difficulty in interpreting Q5.2. Some candidates substituted 60 for P . A few candidates did not determine the value of n correctly. Some candidates did not realise that they had to use the reducing balance depreciation formula.
- (d) In Q5.3 many candidates showed a lack of understanding of different compounding periods. A few candidates did not realise that R20 000 had to be subtracted from the value of the investment after 4 years.
- (e) A few candidates failed to use the calculator correctly.

Suggestions for improvement

- (a) Revision of work done in earlier grades including interest, hire purchase, inflation and other real-life problems should be done.
- (b) Teachers need to 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. Teachers need to emphasise that in scenarios that involve depreciation, the value of P will be greater than the value of A .
- (c) Teachers need to demonstrate to learners how to select the formula that is appropriate for the scenario presented. They should also demonstrate how to change the subject of the formula. It is advised the learners first substitute values in a formula and then change the subject of the formula.

- (d) Teachers should teach all compounding periods (annually, quarterly, monthly, semi-annually/half-yearly and even daily). The use of timelines in order to simplify and better understand a complex problem involving several investments and withdrawals, is strongly advised.
- (e) Learners should note that a good understanding of Financial Mathematics is best developed through practice, using a calculator.

QUESTION 6: CALCULUS

Common errors and misconceptions

- (a) In determining the derivative using first principles in Q 6.1:
 - Some candidates used differentiation rules.
 - A few candidates used incorrect notation by omitting $\lim_{h \rightarrow 0}$ or by placing the $=$ sign in the incorrect position $\lim_{h \rightarrow 0} = \frac{f(x+h) - f(x)}{h}$ or by using the incorrect notation $f'(x) = \lim_{h \rightarrow 0} \frac{f(x+h) - f(x)}{h}$.
 - Some candidates failed to substitute correctly into the formula. Some omitted brackets when substituting $f(x)$.
- (b) In Q6.2.1 candidates failed to differentiate the expression because it did not have x . They realised that π was a constant so they wrote $3,14$ and multiplied by 2.
- (c) In Q6.2.2 most candidates failed to write the surd in exponential form, i.e. \sqrt{x} as $x^{\frac{1}{2}}$. Candidates had difficulty in squaring a binomial. Some candidates failed to apply the exponential laws correctly when they had to multiply or add terms involving x .
- (d) A few candidates integrated the expressions given instead of differentiating it.
- (e) In Q6.3 many candidates failed to interpret the question. They did not know what was expected of them. They did not realise that they needed to substitute point $(-1; -1)$ into $g(x)$ or alternatively work out the derivative of $g(x)$, equate it to the gradient of the tangent to the curve, which was 3 in this case, and substitute the point to solve for a .

Suggestions for improvement

- (a) Teachers should emphasise that when using the first principles, the notation $\lim_{h \rightarrow 0}$ must be written down in each step and should only be left out when writing the final answer, i.e. once the learner has substituted the value of h . The revision on simplification of expressions involving algebraic fractions is encouraged.

- (b) Teachers should expose learners to various notations used in differentiation. $f'(x)$ if $f(x) = x^n$, $\frac{dy}{dx}$ if $y = x^n$, $\frac{d}{dx}(x^n)$ and $D_x(x^n)$ all have the same meaning when one is required to differentiate the expression f with respect to x .
- (c) Revision of exponential and surd laws should be done because differentiation involves working with the exponent.
- (d) Teachers should define and demonstrate the derivative in relation to gradient at a point on a curve or gradient of a tangent.

QUESTION 7: CUBIC FUNCTION

Common errors and misconceptions

- (a) In Q7.2 some candidates did not realise that the factors were given. Instead, they tried to factorise the expanded equation to find the x -intercepts. However, they made errors when factorising the cubic polynomial.
- (b) In Q7.3 some candidates did not equate the derivative function to zero. Many candidates managed to calculate the two correct x -coordinates of the turning points but failed to substitute into the original function when determining the y -coordinates. Most candidates used the quadratic method of finding the turning point without realising that this method was not applicable to cubic functions.
- (c) In Q7.4 many candidates had difficulty in drawing the graph as this question was dependent on responses from Q7.1, Q7.2 and Q7.3.
- (d) Many candidates did not identify the interval in which the derivative function was greater than 0. This led to a wrong answer in Q7.5, as either the notation and/or critical values were incorrect.

Suggestions for improvement

- (a) Learners should read the given information thoroughly and respond to the questions asked.
- (b) Teachers should expose learners to various forms of graphical representations and all aspects of the functions, including sketching and interpretation of the graphs.
- (c) 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 $x = -\frac{b}{2a}$ applies to quadratic functions only.
- (d) A demonstration of where the function is increasing, turning or decreasing within an interval as well as the concepts of maxima and minima should be done with the aid of diagrams. Software such as Geometry Sketch Pad and Graph and GeoGebra, are useful tools to demonstrate these concepts.

QUESTION 8: APPLICATION OF CALCULUS

Common errors and misconceptions

- (a) Most candidates used their calculators to calculate the distance in Q8.1.1.
- (b) In Q8.1.2 many candidates could not determine the expression for the velocity of the car. They substituted 12 in $D(t)$ instead of $D'(t)$.
- (c) Most candidates did not realise they needed to use the given total surface area to write the height in terms of x in Q8.2.1(a).
- (d) In Q8.2.1(b) many candidates did not realise that they had to substitute the answer to Q8.2.1(a) into the given formula for the volume. Many candidates were confused by the two bases and two heights in Q8.2.1(a).
- (e) Many candidates failed to use information from Q8.2.1(b) to respond to Q8.2.2. Some candidates did not work out the derivative. Instead, they assumed that $V = 0$ and therefore factorised and solved for two values of x . Few candidates who managed to determine the derivative failed to equate to 0 but did so implicitly when solving for x .

Suggestions for improvement

- (a) Learners should be exposed to examples involving contextual applications. The concept of maximisation and minimisation should be emphasized.
- (b) Learners need to be taught that when the question asks to 'Show/Prove that ...', it means calculate (justify by means of mathematically correct steps) what is given and the final answer reached must match what is stated in the question.
- (c) Learners must be taught the formulae of different shapes and the manipulation thereof. They need to have a clear understanding of dimensions in different prisms.
- (d) Teachers should explain to learners that the word 'hence' means to use the information obtained in the previous question to solve the question at hand.
- (e) In optimisation, teachers need to emphasise to learners 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 x .

QUESTION 9: INTEGRATION

Common errors and misconceptions

- (a) In Q9.1.1 and 9.1.2, many candidates omitted C when determining the indefinite integrals. Some candidates had difficulty in integrating terms containing fractions.
- (b) In Q9.2 some candidates calculated the area of the shaded part even though it was given. Very few candidates substituted the boundaries in the given function without integrating first. Many candidates failed to subtract the area of the shaded part from the area bounded by the curve and the x -axis between $x = -3$ and $x = 2$.
- (c) Generally, many candidates wrote incorrect notations in Q9.

Suggestions for improvement

- (a) Simplification of expressions involving fractions covered in earlier grades should be revised. Teachers should explain to learners that when determining indefinite integrals, C must always be added. The use of the correct notation should be emphasised.
- (b) When setting up the area notation for definite integrals, learners should be taught to include the lower and upper boundaries. When substituting negative values, the use of brackets should be emphasised.
- (c) Learners should be exposed to more examples to enhance their understanding of integration.

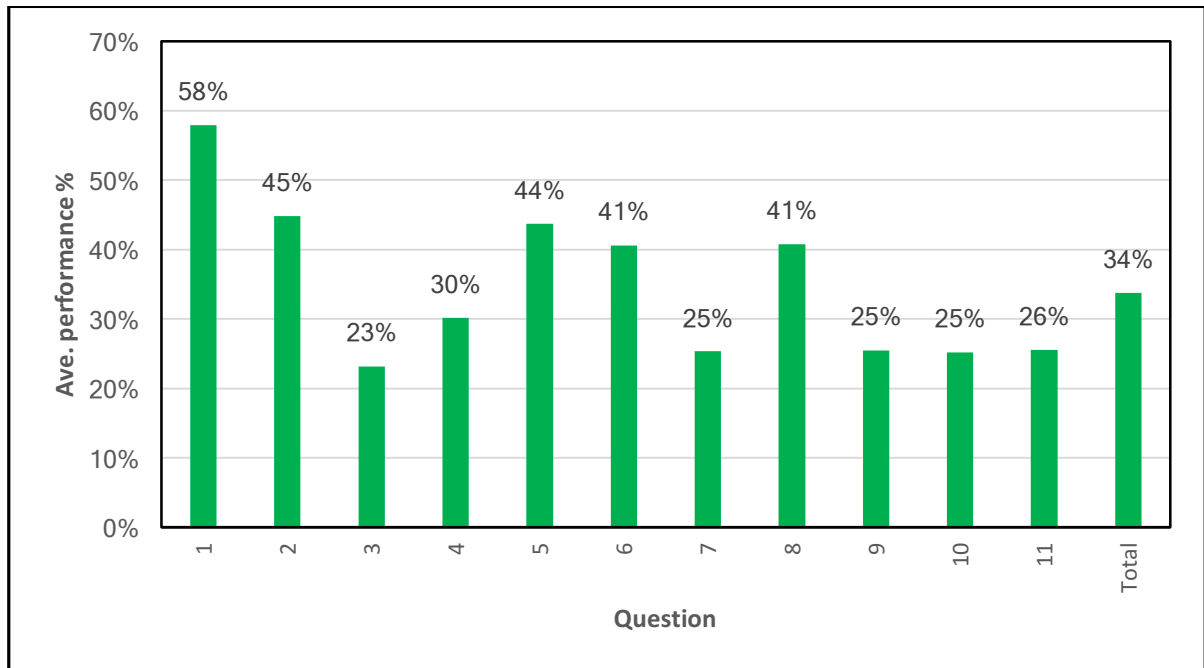
2.5 ANALYSIS OF LEARNER PERFORMANCE IN EACH QUESTION IN PAPER 2

- (a) Candidates performed relatively well in Q1, as they did in 2019. 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 fairly well in Q2, Q5, Q6 and Q8. Q2 was based on Analytical Geometry (equation of the tangent through a point on the circle). Q5 was based on Trigonometric functions, Q6 was on application of trigonometric ratios, area and cosine rules. Q8 was on Euclidean Geometry (application of tan-chord theorem).
- (c) Candidates performed poorly in Q3, Q4, Q7, Q9, Q10, Q11 with Q3 being the worst answered question, just as in 2019. Unlike 2019, these questions largely assessed work covered in Grade 11.
- (d) Candidates did not adhere to the instructions stipulated in the question paper.
- (e) Many candidates did not attempt the higher-order questions.

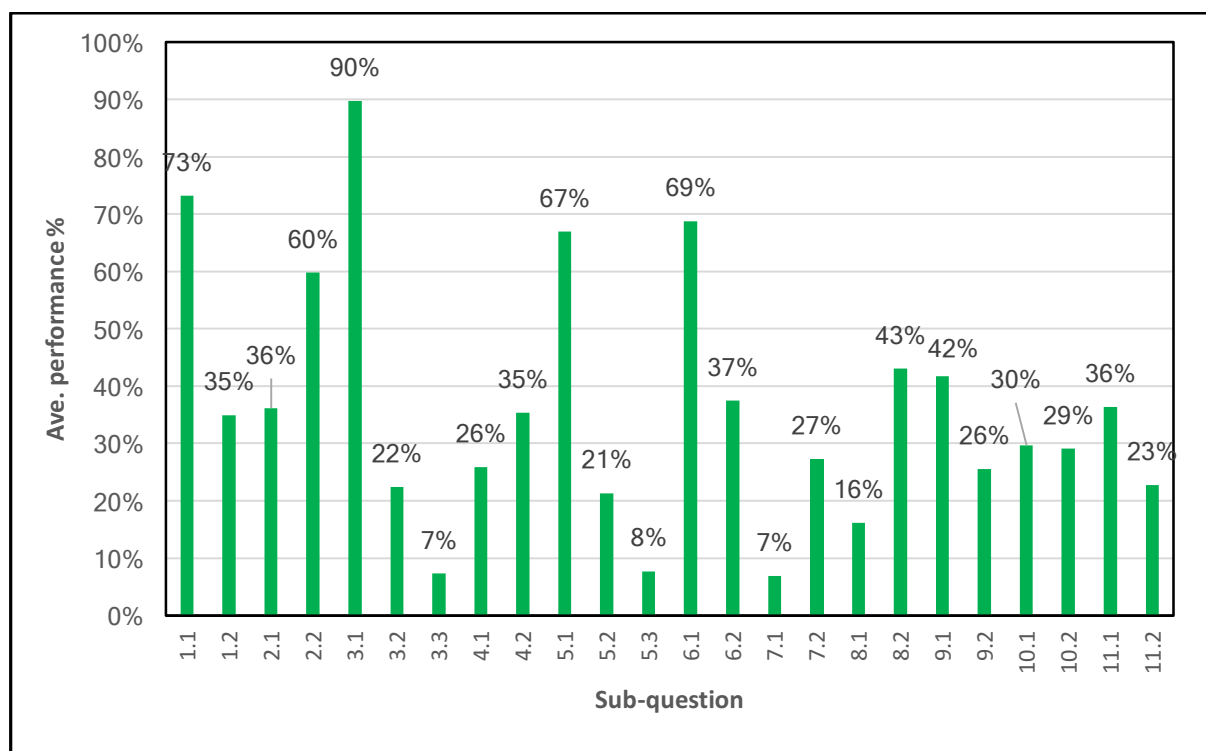
2.6 DIAGNOSTIC QUESTION ANALYSIS OF PAPER 2

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	Topic/s
1	Analytical Geometry
2	Analytical Geometry
3	Trigonometry
4	Trigonometry
5	Trigonometric Functions
6	Height and Distance
7	Euclidean Geometry (opp. \angle s of cyclic quad. and \angle at centre = $2 \times \angle$ at circumference)
8	Euclidean Geometry (tan chord theorem)
9	Euclidean Geometry (\angle s in semi-circle and line from centre \perp to chord)
10	Circles Angles and Angular Movement
11	Mensuration

Graph 2.6.2 Average performance per sub-question in Paper 2


Sub-question	Topic/s
1.1	Gradient and equation of the straight line
1.2	Midpoint and parallel lines
2.1	Equation of the tangent passing through a point
2.2	Equation and plotting an ellipse
3.1	Substitution and use of the calculator
3.2	Drawing diagrams and using them to determine the values of different ratios
3.3	Trigonometric Identities
4.1	Reduction formulae using radian angle and Trigonometric Identities
4.2	Reduction formulae
5.1	Drawing Trigonometric Graphs
5.2	Analysis of Trigonometric Graphs
5.3	Analysing Translated Trigonometric graphs
6.1	Fraction of the line
6.2	Application of Trigonometric ratio, area and cosine rule

Sub-question	Topic/s
7.1	Completing "angles in the same segment" theorem statement
7.2	Application of the theorems (opp. \angle s of cyclic quad. and \angle at centre = $2 \times \angle$ at circumference)
8.1	Completing 'tan-chord' theorem statement
8.2	Application of the parallel lines theorem and tan-chord theorem
9.1	Completing 'line from centre \perp to chord' theorem statement
9.2	Application of the theorems (\angle s in semi-circle and line from centre to midpt. of chord)
10.1	Angle and area of a sector
10.2	Circular movement (diameter and circumferential velocity of rotating blades)
11.1	Mid-ordinate rule
11.2	Surface area and volume of combined geometric figures.

2.7 ANALYSIS OF LEARNER PERFORMANCE IN EACH QUESTION IN PAPER 2

QUESTION 1: ANALYTICAL GEOMETRY

Common errors and misconceptions

- (a) When answering Q1.1.1, candidates did not realise that the answer required an application of the midpoint formula. They also made errors in substitution by swapping coordinates of x and y in Q1.1.2. In Q1.1.3 they used $\tan \theta$ instead of $\tan^{-1} \theta$.
- (b) When answering Q1.2.1 some candidates did not know how to show that lines are parallel. In Q1.2.2 some candidates did not calculate the length of MO and BA, instead they calculated their gradients.

Suggestions for improvement

- (a) Learners should be taught to apply the midpoint formula given the midpoint of the straight line and the coordinates of one of the end points. Teachers should emphasise correct substitution of x and y values. Teachers should explain the difference in calculating the ratio of an angle and the size of an angle.
- (b) Teachers should emphasize the conditions for lines to be parallel and perpendicular. Learners should know the difference between the length and gradient.

QUESTION 2: ANALYTICAL GEOMETRY

Common errors and misconceptions

- (a) Some candidates did not realise that the diameter is double the radius, so they failed to link the two in Q2.1.1.
- (b) Most candidates did not attempt Q2.1.2. They could not relate the gradient of the tangent and that of the radius at the point of contact.
- (c) When answering Q2.2.1, candidates substituted the values of the intercepts incorrectly. Some wrote $\frac{x^2}{12} + \frac{y^2}{3,5} = 1$ and others wrote $\frac{12^2}{x^2} + \frac{3,5^2}{y^2} = 1$.
- (d) In Q2.2.2 the incorrect equation of the ellipse led to candidates drawing the incorrect sketch. Some drew circles and some drew a square.

Suggestions for improvement

- (a) Learners should be trained to write down given information on the sketch. Had they done so, they would have realised that their answer was for the radius and not the diameter.
- (b) Teachers should always integrate different topics in their teaching. The concept of the equation of the tangent at a point requires the application of Euclidean Geometry.
- (c) Teachers should teach learners the standard form of the ellipse and what a and b represent in the equation.

- (d) Learners should know the shape of an ellipse so that they should not draw other shapes when they are asked to draw an ellipse.

QUESTION 3: TRIGONOMETRY

Common errors and misconceptions

- (a) In Q3.1 a few candidates failed to substitute correctly and few made correct substitutions but then calculated incorrectly.
- (b) Some candidates were unable to make calculations based on reciprocal identities.
- (c) In Q3.3.1 candidates did not realise that: $\cos^2 A = 1 - \sin^2 A$.

Suggestions for improvement

- (a) Learners should practise substituting correctly into a formula and using the calculator correctly.
- (b) Teachers should emphasise the importance of drawing a diagram for the given ratio in the correct quadrant. Teachers should teach learners how to calculate reciprocal trigonometric ratios using a calculator.
- (c) Learners should be taught how to manipulate trigonometric Identities.
- (d) Learners should practise algebraic manipulation skills and be competent when performing them in all topics.

QUESTION 4: TRIGONOMETRY

Common errors and misconceptions

- (a) Simplifying trigonometric expressions using identities still proved to be a challenge.
- (b) Candidates were unable to work with the signs of squared trigonometric ratios when applying reduction formulae. They wrote $-\cot^2(180^\circ - x) = -(-\cot^2 x) = \cot^2 x$ instead of $-\cot^2(180^\circ - x) = -(-\cot x)^2 = -\cot^2 x$.

Suggestions for improvement

- (a) Teachers should thoroughly revise the conversion of angle units from radians to degrees and vice versa.
- (b) Teachers should expose learners to a variety of problems that require the use of the different prescribed identities in the solution.
- (c) Learners must be taught that they must use brackets when squaring a negative ratio. Teachers must emphasise the quadrants in which the specific ratio is positive or negative.

QUESTION 5: TRIGONOMETRIC FUNCTIONS

Common errors and misconceptions

- (a) Most candidates managed to draw the sine graph as required in Q5.1. Some candidates were unable to draw the tangent graph because they were confused by the negative sign. Some did not draw the asymptote.
- (b) Many candidates could not determine the period and range of the functions.
- (c) Some candidates were unable to interpret the product of the functions.

Suggestions for improvement

- (a) Teaching how to sketch trigonometric functions should include that of $a \tan x$ for different values of a and this should include negative values of a .
- (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 positive and negative, i.e. positive when it is above the x-axis, zero on the x-axis and negative below the x-axis. Interpretation of graphs should be taught thoroughly and should be included in both informal and formal assessment tasks so that candidates are well prepared to answer similar questions in the NSC examinations.

QUESTION 6: TRIGONOMETRY

Common errors and misconceptions

- (a) Most candidates were able to write down the length of CF in Q6.1. Some made errors in calculation.
- (b) Most candidates were also able to determine the length of AF in Q6.2.1
- (c) Candidates could not apply the cosine rule correctly in Q6.2.2. They wrote the correct formula but were unable to adapt it according to the labels in the given diagram. This resulted in candidates making incorrect substitutions.
- (d) In Q6.2.3 candidates wrote the correct area formula but made incorrect substitutions therein.

Suggestions for improvement

- (a) Learners should be able to calculate a fraction of a given quantity.
- (b) Learners should revise the use of trigonometric ratios to determine the magnitude of the unknown side. This work is done in Grade 10.
- (c) Teachers should revise the sine rule, cosine rule and area rule with many examples that involve changing the subject of the formula, as learners have not mastered this skill.

QUESTION 7: EUCLIDEAN GEOMETRY

Common errors and misconceptions

- (a) Candidates could not recall the statement of the theorem in Q7.1.
- (b) Candidates wrote down the correct size of the required angles but wrote incorrect reasons or incomplete reasons.
- (c) Most candidates struggled to apply Circle Geometry theorems when a combination of these theorems were required to answer a question.

Suggestions for improvement

- (a) During the teaching of Euclidean geometry, teachers should encourage learners to state theorems in full.
- (b) Teachers should give learners more exercises to practice the application of circle theorems. Learners should be urged to use the 'accepted reasons' as stated in the *Examination Guidelines*.
- (c) Learners should be exposed to diagrams that require the application of many theorems.

QUESTION 8: EUCLIDEAN GEOMETRY

Common errors and misconceptions

- (a) Most candidates performed much better when applying the tan-chord theorem. However, they did not indicate which lines were parallel when they used 'alternate angles' as the reason.
- (b) A random selection of angles was used to get to a solution in Q8.3.2. The lack of basic knowledge and the failure to select and apply correct theorems were evident in candidates' responses.

Suggestions for improvement

- (a) Teachers should teach learners to always make logical statements that lead to solving the problem. Learners should indicate and add information on their diagrams as they unpack and solve riders.

QUESTION 9: EUCLIDEAN GEOMETRY

Common errors and misconceptions

- (a) Most candidates did not realise that AC was the chord of the larger circle in Q9.2 and hence they missed important connections.
- (b) Most candidates were unable to prove that the two triangles are similar in Q9.2.4.

Suggestions for improvement

- (a) Teachers should expose candidates to different ways of applying Circle Geometry theorems even when more than one circle is given. They should be taught to view each circle separately first, apply theorems and then look for connections.
- (b) As indicated in the previous report, learners should continue to be exposed to questions that assess the integration of circle theorems and similarity theorems.

QUESTION 10: CIRCLES, ANGLES AND ANGULAR MOVEMENT

Common errors and misconceptions

- (a) Some candidates did not realise that acute $\hat{AOB} = 2\pi - \frac{29}{18}\pi$. In Q10.1.2 some candidates were unable to convert an angle from radians to degrees. When answering, Q10.1.3, some candidates did not select the correct formula of arc length from the formula sheet to calculate the length of radius OA. Others calculated the area of the minor sector in Q10.1.4.
- (b) In Q10.2.1 some candidates did not realise that they were expected to use the height of the segment formula. Some used the correct formula but could not manipulate it to calculate the length of the diameter.
- (c) Some candidates, in Q10.2.2, managed to select the correct formula but made an incorrect substitution. Most candidates struggled to convert revolutions per second to revolutions per minute.

Suggestions for improvement

- (a) Teachers should revise this topic thoroughly as it is only done in Grade 11. They should assess calculations involving both the major and minor sectors so that learners will be able remember when to use an acute angle and when to use a reflex angle.

QUESTION 11: MENSURATION

Common errors and misconceptions

- (a) Some candidates did not realise that the unpainted area was the difference between the area of the full wall and the painted area in Q11.1.3. In addition, they did not round up the number of tins to calculate the cost of the paint.
- (b) In Q11.2 most candidates treated the hemisphere and the cylinder as two separate entities. They also lacked the ability to make sense of the two-dimensional sketch as a three-dimensional object. Most candidates used the total surface given as is without adapting it to the given combined shape.
- (c) Most candidates did not attempt this question because they did not have an idea of the cylindrical tank which they had to compare with the one in the picture.

Suggestions for improvement

- (a) Teachers need to train learners to use the formula sheet. They should also ensure that learners are able to use of mid-ordinate rule correctly. Learners should also know when to round up or round down.
- (b) Teachers should thoroughly revise Mensuration as it is done in Grade 10 and Grade 11. They should revise and teach learners all prescribed shapes and formulae for all basic shapes.
- (c) Learners should be taught how to adapt the formula to calculate surface area and/or volume of regular shapes when they have to deal with combined geometric shapes.

CHAPTER 3

TECHNICAL SCIENCES

The following report should be read in conjunction with the Technical Sciences question papers of the NSC November 2020 examinations.

3.1 PERFORMANCE TRENDS (2018–2020)

In 2020, 11 655 candidates sat for the Technical Sciences examination. The performance of the candidates in 2020 at the above 30% level was 80,4%. This shows a decline when compared to the 2019 performance.

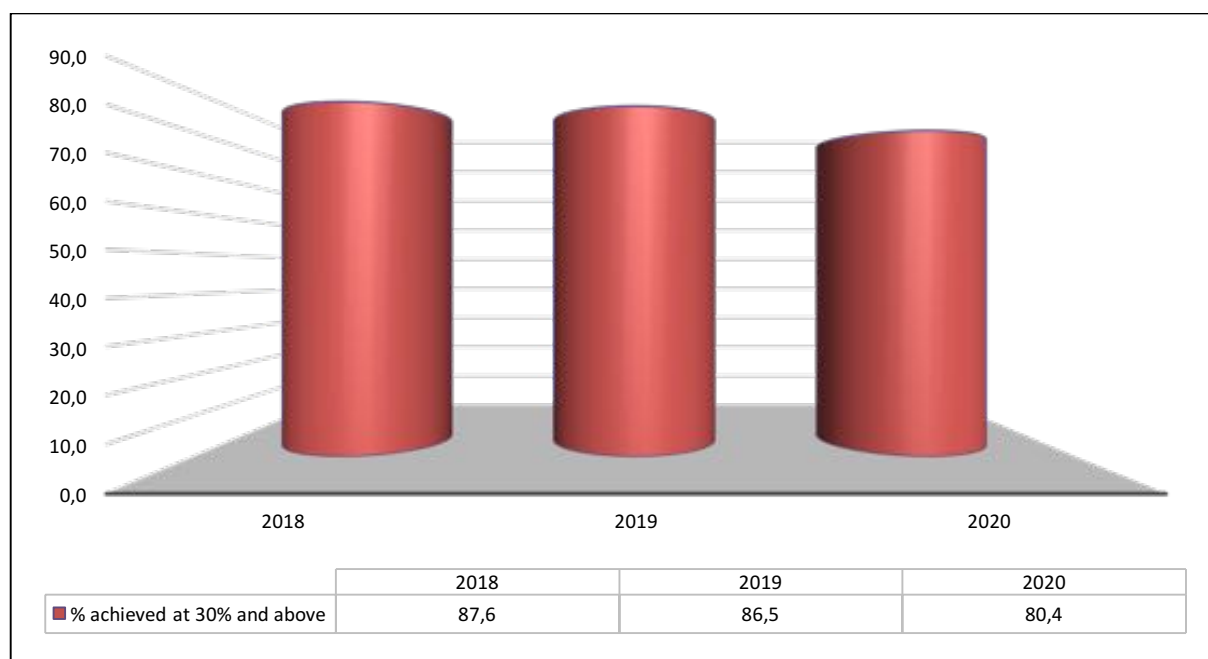
Table 3.1.1 Overall achievement rates in Technical Sciences

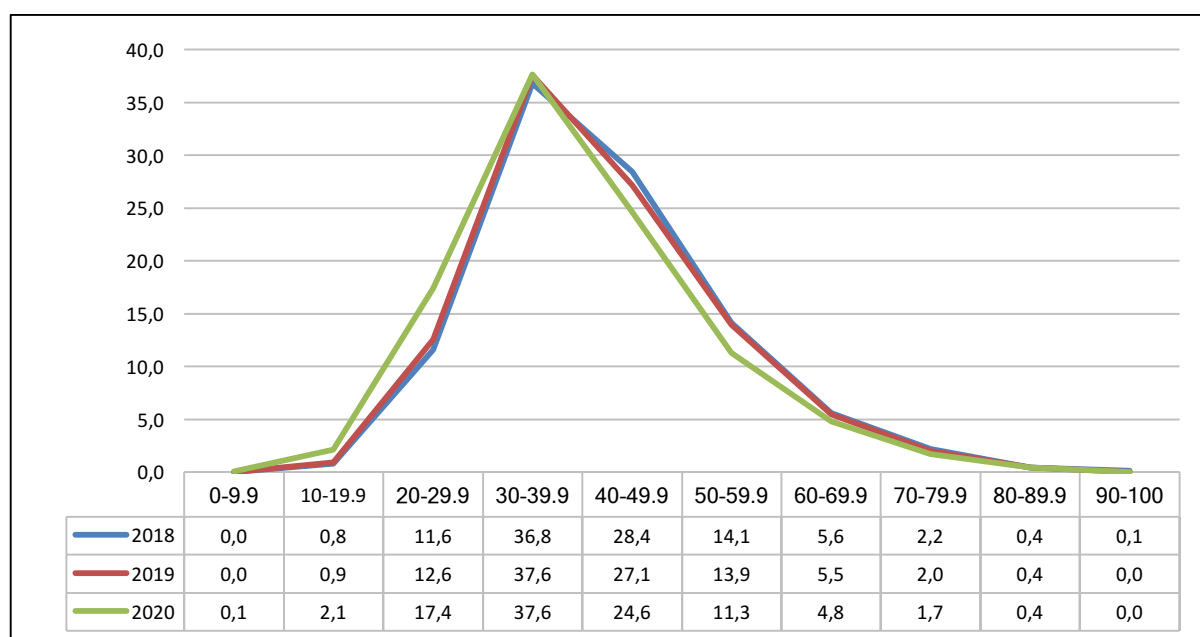
Year	No. wrote	No. achieved at 30% and above	% achieved at 30% and above
2018	10 503	9 204	87,6
2019	10 862	9 401	86,5
2020	11 655	9 375	80,4

The performance of candidates in Technical Sciences in 2020 was good.

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.

Graph 3.1.1 Overall achievement rates in Technical Sciences (percentage)



Graph 3.1.2 Performance distribution curves in Technical Sciences (percentage)

3.2 OVERVIEW OF LEARNER PERFORMANCE IN PAPER 1

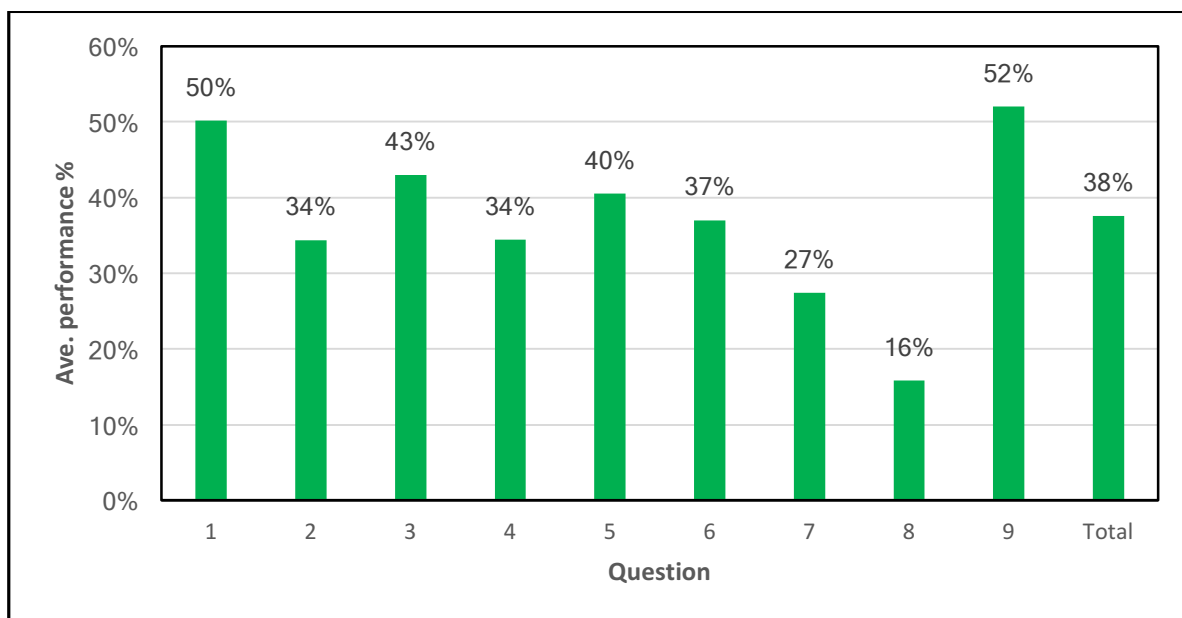
General comments

- The multiple-choice items in Q1 and the questions on Newton's Second and Third Laws of Motion (Q3), Work and Power (Q5) as well as Transformers and Generators (Q9) were generally well answered.
- In general, Q2, Q4, Q6, Q7 and Q8 were poorly answered. Q2 examined Newton's First Law of Motion; Q4 focused on Momentum and Impulse; Q6 dealt with Elasticity, Hydraulics and Viscosity; Q7 examined Electronics and Electric Circuits/Power and Q8 was on Electromagnetic Induction.
- Candidates still struggled with recall questions.
- There was a noticeable improvement in drawing and labelling free-body diagrams. However, some candidates still struggled in this regard.
- 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.

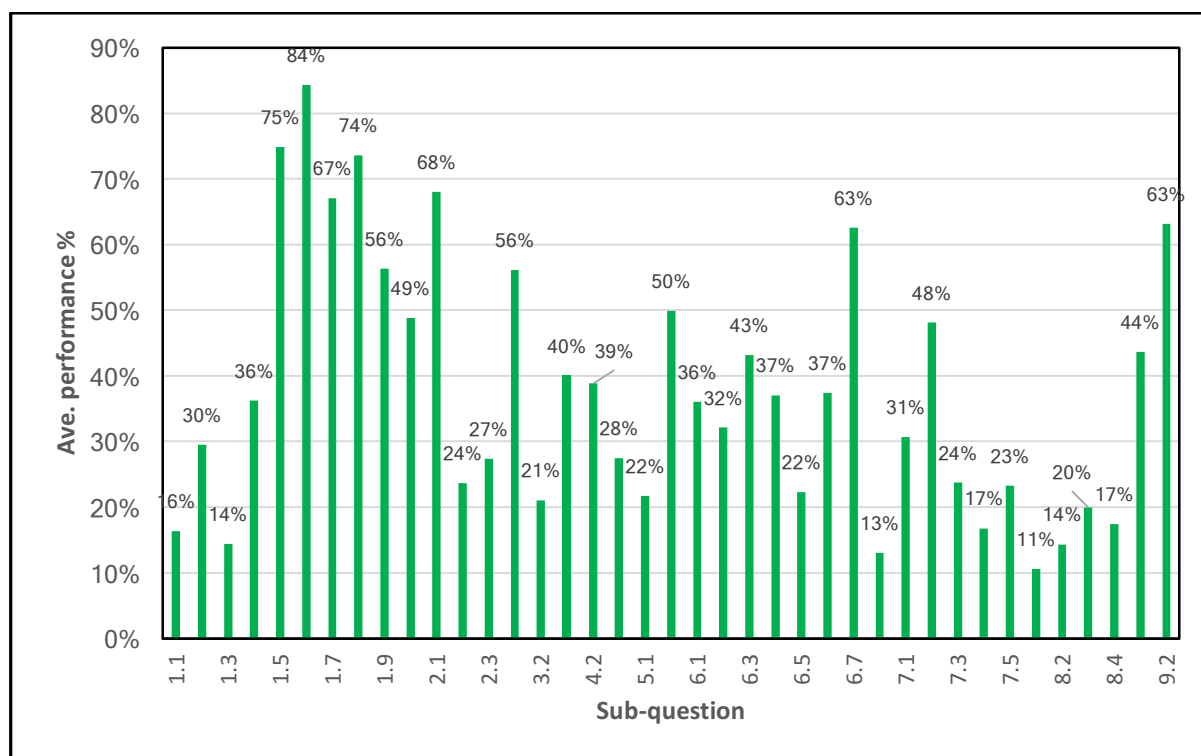
3.3 DIAGNOSTIC QUESTION ANALYSIS OF PAPER 1

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



Q	Topic/s
1	Multiple-choice: All topics
2	Newton's First Law
3	Newton's 2nd and 3rd Law
4	Momentum and Impulse
5	Work and Energy
6	Elasticity, Hydraulics and Viscosity
7	Electronics and Electric Power
8	Electromagnetic Induction
9	Generators and Transformers

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

Common errors and misconceptions

- (a) In Q1.1 a significant number of candidates demonstrated a poor understanding of action-reaction forces acting on an object.
- (b) In Q1.3 candidates showed poor graph analysis skills.
- (c) In Q1.4 most candidates failed to apply the principle of conservation of linear momentum.
- (d) In Q1.9 a significant number of candidates could not define the magnetic flux.

Suggestions for improvement

- (a) Learners must be taught multiple-choice question-answering skills rather than relying on guess work. They must be able to state a reason for eliminating incorrect options in multiple-choice questions.
- (b) Teachers must expose learners to questions across all cognitive levels, including higher-order questions where they analyse complex problems and create solutions, in class work, homework and tests.
- (c) Teachers must teach learners to state the laws and define concepts as required by CAPS and the Examination Guidelines.

- (d) Learners must be given informal assessment tasks to reinforce basic concepts, principles and laws by using, for example, short speed tests (± 10 minutes). These tasks may include content relating to definitions, principles and laws listed in the CAPS and the Examination Guidelines.
- (e) Teachers must enhance learner understanding by giving them informal and formal activities involving interpretation of graphs: using a variety of shapes, in various contexts in all knowledge areas

QUESTION 2: NEWTON'S LAW OF MOTION (First Law)

Common errors and misconceptions

- (a) In Q2.1 and Q2.3.1 candidates omitted key words like *uniform velocity*; *resultant* or *resisting change*.
 - Some confused inertia with Newton's first law of motion.
 - Others gave a completely wrong definition of inertia.
- (b) In Q2.2 most candidates failed to recognise that if an object is travelling at constant velocity, its acceleration is zero and the net force acting on an object will also be zero.
 - They confused acceleration, a , with velocity, v . Some substituted velocity (9 m.s^{-1}) instead of acceleration (0 m.s^{-2}).
 - They struggled to solve problems involving forces applied at an angle.
 - Some candidates wrote the formula as $F \cos 40^\circ - f_k = 0$ instead of $F \cos 40^\circ + f_k = 0$. Those who did so ended up obtaining a positive value for f_k . This incorrectly implied that f_k and F_x were both in the same direction.
 - Others omitted the subscript *net* from the formula $F_{\text{net}} = ma$
- (c) In Q2.3.2 most candidates could not state and use the relationship between inertia and mass to justify their answer.

Suggestions for improvement

- (a) Teachers must train learners to state laws and define concepts without omitting keywords.
 - A list of definitions, principles and laws should be displayed prominently in the classroom.
 - The drill method should be used to reinforce knowledge of basic concepts, definitions, principles and laws.
- (b) Expose learners to questions involving the application of principles and laws of physics by providing explanations using daily real-life situations.
 - Include higher-order questions that involve explaining, justification, synthesis, etc.
 - Scientific reasoning must be infused into teaching and learning.

QUESTION 3: NEWTON'S LAWS (Second and Third laws)

Common errors and misconceptions

- (a) In Q3.1.1 candidates had difficulty defining and identifying a tension force in the diagram.
- (b) In Q3.1.2 most candidates failed to recognise the vertical component of Zane's applied force to lift the object, thus decreasing the magnitude of friction.
- (c) In Q3.1.3 a significant number of candidates committed at least one of the following errors:
 - Drawing a force diagram instead of a free body diagram.
 - Failing to label the forces correctly.
 - Using a line without an arrowhead to represent a force/vector.
 - Arrows not touching a dot.
 - Drawing more than 5 forces.
 - Drawing Zane's force together with its components.
- (d) In Q3.2 most candidates failed to realise that Zane's and Tom's forces are applied force(s).
 - They only wrote $F_{\text{net}} = F_{\text{applied}} + f_k$ and substituted either F_{Zane} or F_{Tom} only instead of writing $F_{\text{net}} = F_{\text{Zane}} \cos 65^\circ + F_{\text{Tom}} + f_k$ and substituting F_{Zane} and F_{Tom} .
 - A significant number of candidates found it difficult to calculate a normal force when there is a force applied at an angle. They calculated the normal force using the equation: $N = mg$, instead of $N = mg - F_{\text{Zane}} \sin 65^\circ$.
 - Some candidates just substituted 160 N instead of $160 \cos 65^\circ$, failing to recognise that the force is applied at an angle of 65° .
 - Others omitted subscripts on the formula, $f_k = \mu_k N$
 - A notable number of candidates wrote units for the coefficient of kinetic friction, μ_k

Suggestions for improvement

- (a) Teach learners the definitions of concepts and reinforce understanding by using relevant examples.
- (b) Learners must be taught the difference between a free body diagram and a force diagram.
 - Emphasise the use of solid lines with arrowheads to represent the forces and that the number of forces must correspond to the mark allocation.
 - The forces must be labelled used acceptable abbreviations.
 - Arrows must be in contact with the dot or an object in case of a free body diagram and force diagram, respectively.

- The drawing of free body diagrams is key to solving problems involving forces acting on objects. Teachers should therefore ensure that learners are able to draw force and free body diagrams and assess them in formal and informal activities. Emphasis must be placed on magnitude, direction and the labelling of forces.
- (c) Teachers must expose learners to multi-step problems involving application of Newton's laws in different contexts.
- (d) Revise Grade 10 and 11 work that is examinable in Grade 12.

QUESTION 4: IMPULSE AND CONSERVATION OF MOMENTUM

Common errors and misconceptions

- (a) In Q4.1.1 most candidates omitted the words, *product of* or *object* when defining momentum.
- (b) In Q4.1.2 and Q4.1.3 the majority of candidates omitted direction in the final answer and omitted units in Q4.1.3.
- (c) In Q4.1.2 candidates struggled to convert $\text{km}\cdot\text{h}^{-1}$ to $\text{m}\cdot\text{s}^{-1}$.
- (d) In Q4.2.1 a notable number of candidates had difficulty stating the principle of conservation of linear momentum.
- Some confused the principle of conservation of linear momentum with the principle of conservation of mechanical energy.
 - Others omitted the keywords like *isolated*, *linear* or *total*.
- (e) In Q4.2.2 a significant number of candidates did not realise that momentum is conserved in both elastic and inelastic collisions.
- They used conservation of total linear momentum to prove that collision was elastic or inelastic instead of using conservation of total kinetic energy of a system.
 - Some candidates started by equating total initial kinetic energy to the total final kinetic energy, $(\sum E_{ki} = \sum E_{kf})$ instead of calculating total initial kinetic energy, $(\sum E_{ki})$ and final kinetic energy, $(\sum E_{kf})$, individually and comparing them later to draw a conclusion.
 - Others failed to realise that they had to substitute the velocity that they calculated in Q4.1.2 for the initial velocity of the truck.
- (f) In Q4.3.3 a notable number of candidates could not state and use/apply the relationship between the net force and contact time to explain how the airbags help to reduce the extent of injuries. They also did not mention that *the impulse will remain constant*.

- (g) In Q4.3.4 most candidates failed to show that F_{net} and initial velocity are vectors acting in opposite directions.
- They ended up with a negative value of time, thus losing 2 marks for that.
 - Some omitted “net” on the formula $F_{\text{net}} = \Delta p / \Delta t$.

Suggestions for improvement

- Keywords must be emphasised when teaching learners to state the laws and define concepts.
- In calculations, teachers must place emphasis on choosing the correct formula, substitution therein, correct answers with correct units and direction in case of vectors.
- It should be stressed to learners that in $\Delta p = \Delta mv$, $\Delta mv = mv_f - mv_i$.
- Learners must be taught that momentum is conserved in both elastic and inelastic collisions. They must use conservation of total kinetic energy only to show that a collision is elastic or inelastic.
- Learners must be taught to calculate total kinetic energy before collision separately from the total kinetic energy after the collision, and then to compare the answers and write a conclusion.
- Conversion of units to SI units must be drilled.
- The relationship between contact time and net force as well as its application in road safety must be explained thoroughly.
- Teachers must give learners a variety of problem-solving activities that involve mathematical skills pertaining to fractions, manipulating the subject of the formula and graphs in formal and informal activities. In calculations, the writing of a correct formula, substitution, correct answer with correct units and direction in case of vectors as well as correct calculator skills, must also be emphasised.
- Different formulae on the datasheets must be used to explain relationships between physical quantities.

QUESTION 5: WORK AND ENERGY

Common errors and misconceptions

- In Q5.1 most candidates substituted $\cos 90^\circ$ or $\sin 90^\circ$ instead of $\cos 0^\circ$. Some omitted the units in the final answer.
- In Q5.1.2 the majority of candidates had a challenge to calculate a net work done. Some overlooked the work done by gravity. Those who considered gravity did not consider the gravitational force to be in opposite direction to the force applied by the girl.
- In Q5.2.1 a significant number of candidates omitted keywords like *gravitational*, *total*, *isolated system* or *remains the same/constant/is conserved*.

- (d) In Q5.2.2 a substantial number of candidates only calculated E_p or E_k instead of E_m . Other candidates used the wrong formula, i.e. instead of using M_E at A, they used $M_A = E_p + E_k$.
- (e) In Q5.2.3 most candidates failed to calculate the kinetic energy at point C correctly.
- Some could not round off the final answer correctly to a minimum of two decimal places as per instruction.
 - They wrote 9.89 instead of 9.90 or 9.899 m.s^{-1} .
 - Others wrote an incorrect unit in the final answer, m.s^{-2} .
- (f) In Q5.2.3 and Q5.2.4 a notable number of candidates were unable to use the 'conservation of mechanical energy' equation for calculation.
- Some candidates used an incorrect formula to calculate velocity.
 - Others wrote incorrect SI units or they omitted the SI unit altogether.

Suggestions for improvement

- (a) Learners must be taught the mathematical skills required for Technical Sciences.
- (b) Learners must be taught the use of $M_E = E_k + E_p$ at various levels of the fall/vertical motion to calculate any of the variables at various points.
- (c) Teachers must give learners more practical problems, where learners could apply the principle of conservation of mechanical energy at any point during the motion of a substance.
- (d) Learners must be exposed to the correct use and understanding of subscripts, e.g. F_{net} , W_{net} , f_k , etc.
- (e) Teachers must integrate the use of instructions and information on page 2 of the question paper in their daily assessment, i.e. learners must be able to:
- Show ALL formulae and substitution in ALL calculations.
 - Round-off FINAL answers to a minimum of TWO decimal places.

QUESTION 6: ELASTICITY, HYDRAULICS AND VISCOSITY

Common errors and misconceptions

- (a) In Q6.1.1, Q6.1.2, Q6.4 and Q6.6 keywords were omitted from laws or definitions. For instance, in Q6.1.1 the words *internal or/and restoring* were omitted.
- (b) In Q6.1.2 the word *rate* or *ration* was used instead of *ratio*. In some cases, *ratio* was omitted.
- (c) In 6.2.1 most candidates had difficulty choosing the correct formula to calculate strain. Some used $\varepsilon = \frac{\Delta l}{L}$ instead of $K = \frac{\sigma}{\varepsilon}$.
- (d) In Q6.2.1 and Q6.2.2 a large number of candidates could not interpret the meaning of prefixes like *milli*, *mega*, *giga*, etc. Some had difficulty in calculating the area of a bar.

- (e) In Q6.3 candidates were unable to determine the effect of temperature on viscosity.
- (f) In Q6.4 and Q6.5 most candidates had difficulty in defining and giving examples of a perfectly elastic body. They omitted the phrase *when the deforming force is removed* and other keywords like *does not show a tendency; to regain and deforming or shape and size*.
- (g) In Q6.7 candidates lost marks for omitting key phrases like *in a continuous liquid at equilibrium* or *transmitted equally* when stating Pascal's law.
- (h) In Q6.8 almost all candidates appeared to have no knowledge of what a *thrust* of a liquid is.

Suggestions for improvement

- (a) Learners must be taught definitions of all concepts and how to state laws in this section without omitting keywords in definitions as prescribed in CAPS and the Examination Guidelines.
- (b) Conversion of units and meaning of prefixes must be taught.
- (c) Learners must be given enough activities to practise correct conversion of units. Rounding off must be done as instructed.
- (d) Teachers should ensure that learners are fully familiar with the datasheet and that they are able to identify the relevant equation applicable to a specific calculation.

QUESTION 7: SEMICONDUCTORS, CAPACITORS AND ELECTRIC POWER

Common errors and misconceptions

- (a) In Q7.1.1 a notable number of candidates failed to identify the semiconductor materials in the diagram. Some of their responses included *cathode* and *anode* or *electrons* and *protons*.
- (b) In Q7.1.2 most candidates could not draw the p-n junction.
- (c) In Q7.2 a significant number of candidates had difficulty explaining how various factors affect the capacitance of a capacitor. Some wrote *increase the surface area* instead of *decrease the surface area*. Others wrote *decrease the distance between the plates*.
- (d) In Q7.5 most candidates had difficulty calculating the cost of electricity.
 - Some calculated power only and did not calculate energy and cost of electricity.
 - Others failed to convert energy used to kWh.
 - There were those candidates who omitted the formula: $\text{Cost} = E_{\text{used}} \times \text{tariff}$, so they lost 1 mark.

Suggestions for improvement

- (a) Learners must be taught symbols for p-n junction diode.
- (b) Teachers must integrate multi-step problems in their daily teaching and assessment.
- (c) Teachers must encourage learners to show all their working in calculations, i.e. formulae, substitution and final answer with correct units.
- (d) Teachers should teach learners to refer to the periodic table to identify the intrinsic semiconductors and their valence electrons using the group numbers.

QUESTION 8: ELECTROMAGNETIC INDUCTION

Common errors and misconceptions

- (a) In Q8.1 a significant number of candidates struggled to define *electromagnetic induction*. Some confused it with Faraday's law (of electromagnetic induction).
- (b) In Q8.2 candidates failed to state the factors that influence the induced emf.
 - Some omitted key words like *coil* or *magnetic field*.
 - Other just wrote *magnetic field* instead of *strength of magnetic field*, or *number of turns* instead of *number of turns in a coil*.
- (c) In Q8.3 most candidates had difficulty stating Lenz's law.
 - Some confused it with Faraday's law.
 - Others omitted key words like *direction of*; *induced emf*; *opposes the effect that produce it*.
- (d) In Q8.4 candidates had a challenge when stating daily applications of Lenz's law.

Suggestions for improvement

- (a) Learners must be taught all concepts, definitions, terminology, laws and principles as defined or stated in CAPS and the Examination Guidelines.
- (b) Factors affecting the emf must be explained thoroughly.
- (c) Teachers must emphasise the difference between Faraday's and Lenz's law. They must also explain daily application of these laws in the context of technology.
- (d) The relationship between variables should be explained.

QUESTION 9: GENERATORS AND TRANSFORMERS

Common errors and misconceptions

- (a) In Q9.1.1 a significant number of candidates wrote *south pole of the magnet* instead of *magnet*. Others wrote *magnetic field*.
- (b) In Q9.1.2 candidates failed to identify the type of motor, AC or DC.
- (c) In Q9.2 most candidates substituted incorrectly or wrote down the formula incorrectly instead of copying it directly from the formula sheet. Some had difficulty identifying *turn* in primary and secondary coils.

Suggestions for improvement

- (a) Teachers must teach learners different parts of the motor and generators as well as the functions of these parts.
- (b) 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.
- (c) Teachers must emphasise the writing of correct formula, substitution and the need to have units in the final answer.

3.5 ANALYSIS OF LEARNER PERFORMANCE IN EACH QUESTION IN PAPER 2

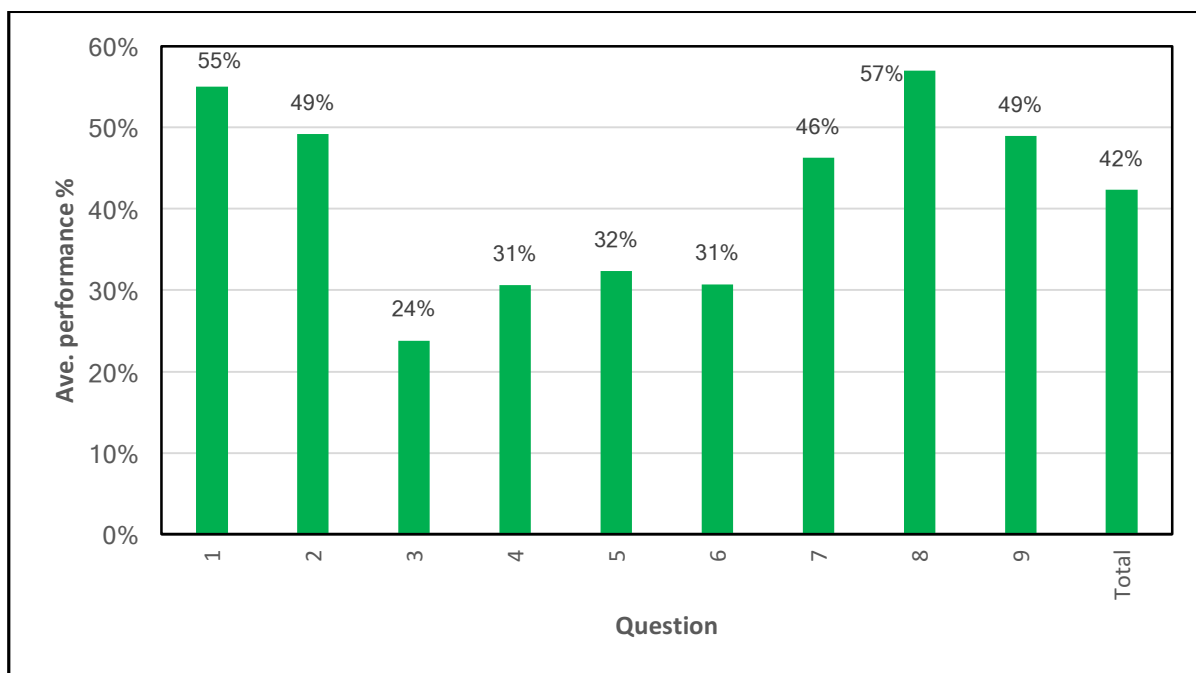
General comments

- (a) Questions on definitions were poorly answered.
- (b) Candidates could not apply scientific reasoning to explain certain phenomena.
- (c) Physical properties of organic compounds in Q3, organic reactions in Q4, electrolytic cell in Q5 and galvanic cell in Q6 were poorly answered. Candidates struggled with a drawing of the galvanic cell in Q6.
- (d) Most candidates struggled with the interpretation and understanding of the flow diagram in Q4.
- (e) Questions on drawing light ray diagrams and lenses were poorly answered.
- (f) Candidates struggled with the interpretation of a table and a graph in Q3.
- (g) The interpretation and the use of the table of standard reduction potentials posed a challenge to candidates.

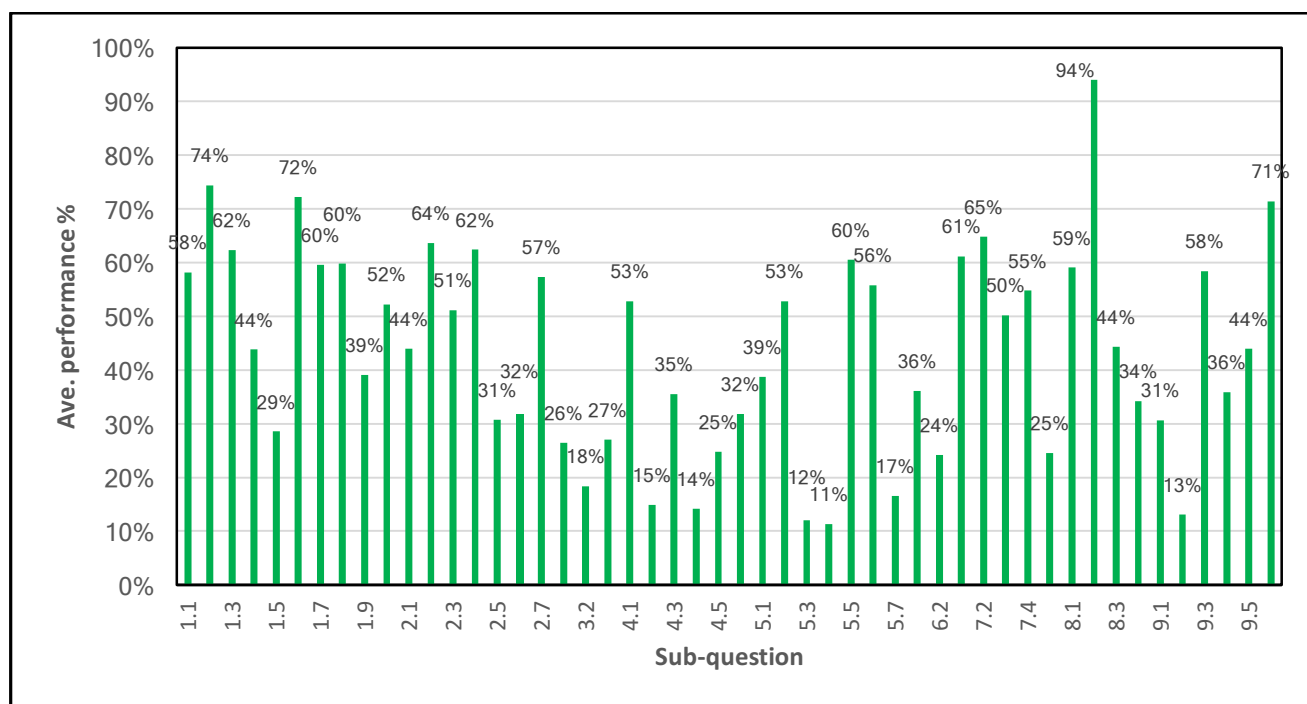
3.6 DIAGNOSTIC QUESTION ANALYSIS OF PAPER 2

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	Topic/s
1	Multiple-choice
2	Organic Molecules: Nomenclature
3	Organic Molecules: Physical Properties
4	Organic molecules: Reactions
5	Electrolytic cell
6	Galvanic cell
7	Light: Reflection and refraction
8	Light: Reflection and refraction
9	Electromagnetic radiation

Graph 3.6.2 Average performance per sub-question in Paper 2

3.7 ANALYSIS OF LEARNER PERFORMANCE IN EACH QUESTION IN PAPER 2

QUESTION 1: MULTIPLE CHOICE

Common errors and misconceptions

- (a) In Q1.1 candidates failed to recall that for a secondary alcohol the carbon where the functional group is attached must be bonded to two other carbons.
- (b) Candidates could not rank the intermolecular forces according to increasing strength in Q1.3.
- (c) In Q1.4 candidates could not identify the *homologous series* of a compound formed when alkene reacts with hydrogen.
- (d) Most candidates failed to identify *cations* as positive ions that will be attracted to the negative electrode (cathode) of an electrolytic cell in Q1.5.
- (e) Candidates could not relate wavelength or frequency of different colours of light in the visible spectrum to the degree of refraction in Q1.9.
- (f) In Q1.10 candidates could not identify the type of lens that converges light rays and the focal length when the point where the image is formed is shown in the given diagram.

Suggestions for improvement

- (a) Teachers should explain that the number of carbon atoms bonded to the carbon where the functional group is attached is used to identify a primary, secondary or tertiary alcohol.
- (b) Teachers need to make sure that learners can differentiate between the different types and strengths of intermolecular forces.
- (c) It is important that learners understand that each intermolecular force occurs at specific organic molecules or homologous series.
- (d) Emphasis should be on the difference between the homologous series.
- (e) The different types of reactions should be thoroughly taught, and reference should be made to CAPS and the Examination Guidelines to determine which reactions to teach.
- (f) Learners must be taught to represent organic reactions using structural formulae when identifying the type of reaction or the product formed.
- (g) The migration of the anions and cations in the galvanic and electrolytic cells should be thoroughly explained. Emphasis must be given to the polarity of the electrodes in both the electrolytic and the galvanic cell and the type of reaction taking place in both electrodes.
- (h) Dispersion of white light through a triangular glass prism should be thoroughly explained with the aid of experiments, simulations and videos. Reference to the degree of refraction for each colour of light during dispersion should be addressed with the aid of a diagram.
- (i) Terminology relating to lenses should be emphasised. Diagrams should be used for the formation of images for the concave and convex lenses and to illustrate focal point, focal length, etc.
- (j) Daily activities, informal and formal assessment should include multiple-choice questions. Teachers are encouraged to compile a test bank of MCQs for each topic for learners. In answering these, learners must justify their choices.

QUESTION 2: NAMING OF ORGANIC MOLECULES AND STRUCTURAL FORMULAE

Common errors and misconceptions

- (a) In Q2.1 candidates confused the definition for *functional group* with *homologous series* and omitted the words '*atom*' or '*group of atoms*'.
- (b) When naming compounds in Q2.3.1 and Q2.3.2, candidates included the position of the functional group in aldehydes and carboxylic acids.

For example: 1-Hexanal instead of Hexanal
1-Propanoic acid or Prop-1-noic acid instead of Propanoic acid
- (c) When drawing structural formulae for but-2-ene in Q2.4.1, candidates put the double bond in the first carbon instead of the second carbon and had more bonds than necessary around carbon atom with a double bond.

- (d) In Q2.5.1 and Q2.5.2 candidates drew the structural formulae of but-2-ene and propanoic acid instead of their isomers.
- (e) Most candidates could not identify the type of isomers in Q2.6.1 and Q2.6.2.
- (f) In Q2.7.2 candidates did not include the words 'between carbon atoms' in their explanation of why but-2-ene is an unsaturated compound.

Suggestions for improvement

- (a) Teachers must emphasise the inclusion of the key words when defining concepts.
- (b) Greater emphasis should be placed on the learning of definitions listed in CAPS and the Examination Guidelines and they should be assessed in informal and formal activities.
- (c) Differentiate, using examples, between the functional group, functional group name and homologous series.
- (d) The structural formula of the functional groups and compounds in the different homologous series should form part of the daily assessment activities.
- (e) The rules of IUPAC naming of organic compounds must be emphasised, e.g. the number, comma and hyphen should be placed correctly. Emphasise the fact that a hyphen is only used between a letter and a number in the IUPAC name and a comma is only placed between two numbers when having multiple locations of additional attachments to the parent chain.
- (f) Learners must be assessed on different structural isomers (chain, functional and position) in terms of naming, identifying and drawing.

QUESTION 3: PHYSICAL PROPERTIES OF ORGANIC COMPOUNDS

Common errors and misconceptions

- (a) In Q3.1 candidates omitted some key words when defining *vapour pressure*, for example 'The pressure exerted by a liquid and a solid in a closed system' and some confused the definition of vapour pressure with that of temperature.
- (b) Candidates could not interpret the table to explain the trend of vapour pressure. Reference to chain length/molar mass, strength of the intermolecular forces and energy was done but there was no comparison between the compounds given in the table in Q3.2.2. In their explanation there was no comparison between the compounds. For example, 'As the chain length/molar mass increase, the intermolecular forces increase, and then more energy is needed to overcome the intermolecular forces'.
- (c) Candidates failed to identify the correct homologous series represented by the given graphs in Q3.3.1. They did not seem to understand how to interpret the given graphs of the relationship between boiling point versus the number of carbon atoms and how to use that information to identify the homologous series represented by the graphs.
- (d) In Q3.3.2 candidates could not identify the correct type of intermolecular forces and compare the strength of the forces in alkanes and aldehydes in order for them to explain the difference in their boiling points. They struggled to explain which type of intermolecular force is stronger.

Suggestions for improvement

- (a) Learners should be taught definitions and the necessary keywords should be emphasised. Informal assessment of definitions should be done regularly.
- (b) Learners must be taught to be specific about the type of intermolecular forces and the strength of intermolecular forces acting on different organic compounds.
- (c) Learners should be given more questions on interpretation of graphs and tables.
- (d) Learners must be encouraged to give their explanation in point form addressing structure, relationship and energy rather than in a paragraph. For example:

STRUCTURE: State which factor from the given structures influences the strength of intermolecular force (chain length, branching, type of intermolecular force, homologous series) They need to be specific when making comparisons.

RELATIONSHIP: Explain how the above factor influences the strength of the intermolecular force. They need to be specific and mention which one has strong intermolecular force and vice versa.

ENERGY: The stronger the intermolecular force, the more the energy will be needed to overcome the intermolecular force instead of stating “to overcome the bond or substance”.

- (e) Learners must be guided on how to use chain length, type of intermolecular forces, strength of the intermolecular forces and energy to explain trends in physical properties of organic compounds. Emphasis should be on the comparison between the given compounds.
- (f) Learners must mention both compounds when comparing two compounds, and should be specific about the factors which are compared rather than being too general.
- (g) Teachers must encourage learners to read the questions and follow instructions.

QUESTION 4: REACTIONS OF ORGANIC COMPOUNDS**Common errors and misconceptions**

- (a) Candidates could not name and differentiate between the different types of reactions. In Q4.1.1, Q4.1.2, Q4.1.3 candidates interchanged the names of the compounds with the types of reaction.
- (b) Candidates struggled to name the other reactant needed to react with ethene to form ethanol in Q4.2.1 and to recall the catalyst needed for the reaction in Q4.2.2.
- (c) In Q4.3 candidates used molecular formulae instead of structural formulae for the halogenation of ethene to form bromoethane. Those who managed to use structural formula to write a balanced equation for the reaction of ethane with HBr made the following common mistakes:
 - Wrong symbols used, Hbr instead of HBr.
 - Reaction written without an arrow to separate reactants from the products.
 - Drawing only the product instead of the reaction.

- (d) In Q4.4 candidates failed to state the reaction conditions for the substitution reaction of an alcohol to form a haloalkanes, for example: 'Heat' instead of *mild heat*, 'sulphuric acid' instead of *dilute sulphuric acid* and 'excess water' instead of *no water*.
- (e) Candidates struggled to write a balanced equation for the combustion of butene in Q4.5. When the reactants and products were correctly written, they could not balance the equation.
- (f) In Q4.6 most candidates wrote the name of the homologous series instead of the name of the monomer e.g. alkene instead of ethene.

Suggestions for improvement

- (a) During teaching, emphasise the difference between the different types of reactions (combustion/oxidation, substitution reactions and the different types of addition reactions) as well as their reaction conditions. When writing organic reactions, learners must always write the reactants, conditions of reaction and then products.
e.g. Reactants $\xrightarrow{\text{conditions}}$ Products
- (b) Encourage learners to use structural formulae to write down a balanced chemical reaction in the flow diagram.
- (c) Emphasise the difference between molecular structure, structural formulae and condensed structural formulae.
- (d) Writing of balanced combustion reactions should be assessed in formal and informal activities. It should be emphasised that the products in any combustion reaction of hydrocarbons will be CO₂ and H₂O. When balancing combustion reactions, learners must be encouraged to start balancing the carbon atoms, followed by hydrogen atoms and then oxygen atoms.
- (e) Use a variety of flow diagrams and teach IUPAC naming of organic compounds and interpretation of the flow diagram. This knowledge should be assessed in all assessment tasks, both formal and informal.
- (f) Distinguish between IUPAC names of organic compounds and the names of the homologous series.
- (g) The topic on polymers should be thoroughly taught.

QUESTION 5: ELECTROLYTIC CELL

Common errors and misconceptions

- (a) In Q5.1 candidates defined *electrolysis* as a cell not a process, e.g. 'Electrolysis convert electrical energy to chemical energy'. There was evidence of incorrect energy conversions given in definitions, e.g. 'chemical energy is converted to electrical energy', and some candidates even wrote '*electrical energy* is converted to *mechanical energy*'.
- (b) Most candidates struggled to explain why the electrolysis of copper (II) chloride is a non-spontaneous reaction in Q5.3. Some wrote that 'it is a reaction that requires energy' instead of writing 'it is a reaction that requires electrical energy'.

- (c) In Q5.4 most candidates could not write down the formula of the electrolyte for the electrolysis of copper (II) chloride even though the name was given. Some wrote the formula incorrectly as CuCl instead of CuCl_2 .
- (d) Candidates failed to match the observations given of the electrolysis of copper (II) chloride to the electrodes in Q5.5.1 and Q5.5.2.
- (e) Candidates confused the definition of *reducing agent* with that of *oxidation* in Q5.6. They defined reducing agent as 'loss of electrons' instead of 'a substance that is oxidised or loses electrons'.
- (f) In Q5.7.1 and Q5.7.2 candidates were unable to write the half-reactions of reactions occurring at the anode and cathode. They used double arrows for half-reactions and omitted the charges in the ions. They swapped the half-reaction at the anode with that of the cathode.
- (g) Candidates were unable to write down the nett cell reaction in Q5.7.3. They omitted ions and some left out charges on ions, e.g. Cu instead of Cu^{2+} and Cl instead of Cl^- . Others swapped reactants and products. Some learners wrote the *cell notation* instead of the *net cell reaction*.

Suggestions for improvement

- (a) The difference in energy changes occurring in an *electrolytic* and a *galvanic cell* must be emphasised.
- (b) There should be a clear explanation of spontaneous and non-spontaneous reactions and the type of cells associated with each reaction.
- (c) The process of how the ionic substance breaks down into different substances at specific electrodes in an electrolytic cell should be thoroughly explained. Perform experiments or use videos of a variety of electrolytic reactions and teach learners how to make observations.
- (d) Definitions, with the emphasis on the key words, and the difference between *reducing agent*, *oxidizing agent*, *oxidation* and *reduction* should be addressed.
- (e) Learners should be taught to use the table of standard reduction potentials to write oxidation and reduction half-reactions, to identify the oxidising and reducing agents and to write the overall net cell reactions.

QUESTION 6: GALVANIC CELL

Common errors and misconceptions

- (a) In Q6.1.2 candidates struggled to draw the diagram of the Zn-Cu cell even though the cell notation was given. Common errors included:
 - Drawing an electrolytic cell instead of a galvanic cell
 - Swapping the anode and cathode
 - The salt bridge was not labelled and sometimes merged with the conducting wires and the electrodes

- The direction of the flow of electrons in the external circuit was not indicated or was incorrectly drawn
 - The electrodes were put in the wrong solutions
- (b) Candidates failed to write the correct values for standard conditions for the zinc-copper cell in Q6.1.3 or wrote the correct values with incorrect units.
- (c) Candidates could not explain why the anions in the salt bridge migrate to the anode/zinc half-cell in Q6.1.4. Their response was 'complete the circuit' which was not an appropriate answer.
- (d) In Q6.2.1 most candidates struggled to calculate the E° value of the anode. Common errors included:
- Calculating the E°_{cell} for the zinc-copper cell
 - Wrong E° values were substituted
 - They also used unconventional abbreviations in the formula, e.g. $E_{\text{cell}} = E_{\text{cat}} - E_{\text{an}}$ and the incorrect formula, e.g. $E_{\text{cell}} = \text{Anode} - \text{Cathode}$ even though it was given in the formula sheet
 - The final answer had no unit or was written with incorrect unit
 - Candidates could not identify electrode X
- (e) Most candidates found it difficult to write the half reaction taking place at the anode in Q6.2.2. Candidates wrote the oxidation half reaction of zinc instead of aluminium.
- (f) In Q6.2.3 candidates could not identify the electrode which would experience a decrease in mass and were unable to explain why there was a decrease in Q6.2.4.

Suggestions for improvement

- (a) Drawing and labelling of electrochemical cells should be assessed in formal and informal activities.
- (b) Emphasis should be placed on writing the correct values of the standard conditions of the galvanic cell with the correct SI units.
- (c) Teachers should explain how the salt bridge maintains electrical neutrality of the cell through the movement of ions. Use simulations to explain how the ions move in the salt bridge and why specific ions are moving to a specific half-cell.
- (d) Teachers should ensure that learners understand how to use the table of standard reduction potentials to write half-reactions and the net cell reaction.
- (e) Learners should be able to identify and compare the strength of the reducing and the oxidizing agents using the table of standard reduction potentials.
- (f) Calculations relating to the emf of the cell should be assessed informally and formally. They should not be restricted to only calculation of the E°_{cell} but also for E°_{cathode} and E°_{anode} .

- (g) It should be emphasised that the electrode which undergoes oxidation is the one that experiences loss of mass (anode).
- (h) Terminology relating to electrolytic cells should be reinforced because it forms the basis for understanding the operation and the difference between the cells.
- (i) Practical work (Experiment) of the galvanic cell should be infused in the lessons.

QUESTION 7: REFLECTION AND REFRACTION OF LIGHT

Common errors and misconceptions

- (a) In Q7.1.1 candidates could not define the term *reflection* and confused it with the *law of reflection*.
- (b) In Q7.1.3 candidates could not differentiate between *reflected ray* and *refracted ray*.
- (c) Candidates confused *angle of reflection* with *emergent angle* in Q7.1.6.
- (d) Most candidates could not name the phenomenon where light ray changes direction when it travels from air to water in Q7.4.3.
- (e) Candidates struggled to define *critical angle* in Q7.5.1. The common error committed in their definition was to write 'the incident ray in a medium ...' instead of the 'incident angle in a denser medium ...'.
- (f) In Q7.5.2 candidates could not write what would be the observation when a light ray moves from water to air when the angle of incidence is smaller than the critical angle. Some stated that the light ray will bend and they did not specify whether it will bend towards the normal or away from the normal.
- (g) In Q7.5.3 candidates confused the phenomenon of *total internal reflection* with its conditions.

Suggestions for improvement

- (a) The definition of the concepts, *reflection* and *refraction*, and laws should be emphasised using the Examination Guidelines and CAPS.
- (b) Prescribed and recommended experiments should be conducted to emphasise the learnt concepts relating to *reflection*, *refraction* and *total internal reflection* so that candidates enhance learning and develop practical skills including observation and reasoning.
- (c) The concept of *reflection* and *refraction* can easily be explained and demonstrated by means of experiments, videos, and simulations.
- (d) Differentiate between angle of incidence, angle of reflection, angle of refraction and the emergent angle through the use of ray diagrams.
- (e) The concept of *refraction* should be clarified with learners and detailed emphasis on the direction the light ray will bend to relative to the normal.

QUESTION 8: REFLECTION AND REFRACTION OF LIGHT

Common errors and misconceptions

- (a) When defining *dispersion* in Q8.1, some candidates omitted the words 'white light ...' and just wrote 'light ...'. Others wrote 'white colour break up into component colours' instead of writing 'white light breaks up into component colours'.
- (b) In Q8.3, when stating the properties of the image in a plane mirror, the following errors were made:
 - 'same size' without any comparison to the object size
 - 'same distance' instead of 'the distance from the image to the mirror is the same as the distance from the mirror to the object'
- (c) In Q8.4.2 candidates struggled to complete the path of the light ray after passing through a convex lens. When the diagram was correctly drawn, the direction of the light ray was incorrectly drawn or omitted. Some candidates used broken lines to draw ray diagrams or drew more than one light ray after passing through the lens.
- (d) Most candidates struggled in Q8.4.3 to complete the path of the light ray after passing through a concave lens. When the diagram was correctly drawn, the direction was omitted. The extrapolation was not done until at F.

Suggestions for improvement

- (a) Key words should be emphasised in definitions.
- (b) The difference between the terms *refraction*, *reflection*, *dispersion* and *spectrum* should be emphasised. Various teaching aids such as videos and the optical kit can be used to demonstrate refraction, reflection and dispersion of light.
- (c) The relationship between frequency of light, wavelength and the degree of refraction should be clarified. Experiments can be used to show the relationship.
- (d) Teachers must ensure that learners master the drawing of ray diagrams for convex and concave lenses. The applicable terminology such as *focal point*, *focal length* and *principal axis* must be clearly explained.
- (e) Properties of images formed by these lenses at various positions from the optical centre should be addressed.
- (f) It should be thoroughly emphasised that light rays that pass through a convex lens will converge, and that light rays that pass through a concave lens will diverge.
- (g) Teach learners the difference between a *virtual* and a *real image*. Discuss the properties of the images formed in terms of size, position, type of image and whether the image is upright or inverted.

QUESTION 9: ELECTROMAGNETIC WAVES

Common errors and misconceptions

- (a) Candidates struggled to define the term *electromagnetic wave* in Q9.1.
- (b) In Q9.2 candidates could not name a property of radio waves which make them suitable to transmit signal over long distances.
- (c) In Q9.3 candidates defined a photon as a 'quantum of electromagnetic wave' or 'a packet of light or 'wave' instead of 'a quantum of energy'
- (d) Candidates struggled to name the uses of electromagnetic waves in Q9.4.1, Q9.4.2 and Q9.4.3.
- (e) Candidates failed to compute the values correctly and lost a mark for the answer to Q9.6. There was evidence of incorrect rounding off and the omission of SI units or the wrong unit used in the final answer. The unit of energy, Joule (J) was written with a small letter (j).

Suggestions for improvement

- (a) The definitions of concepts should be emphasised using the Examination Guidelines and CAPS. Teachers should highlight keywords in definitions while teaching.
- (b) The relationship between properties of electromagnetic radiation and their application should be discussed.
- (c) Explain why certain electromagnetic waves are suitable for specific purposes.
- (d) Teachers must ensure that learners know how to use the calculator to compute the substituted values correctly.
- (e) Teachers must expose learners to a variety of calculations involving energy of a photon and ensure that conversion of units is done correctly. Teachers must emphasise that the final answer should have the correct units.

CHAPTER 4

CIVIL TECHNOLOGY

4.1 CIVIL SERVICES

The following report should be read in conjunction with the Civil Services question paper of the November 2020 Examinations.

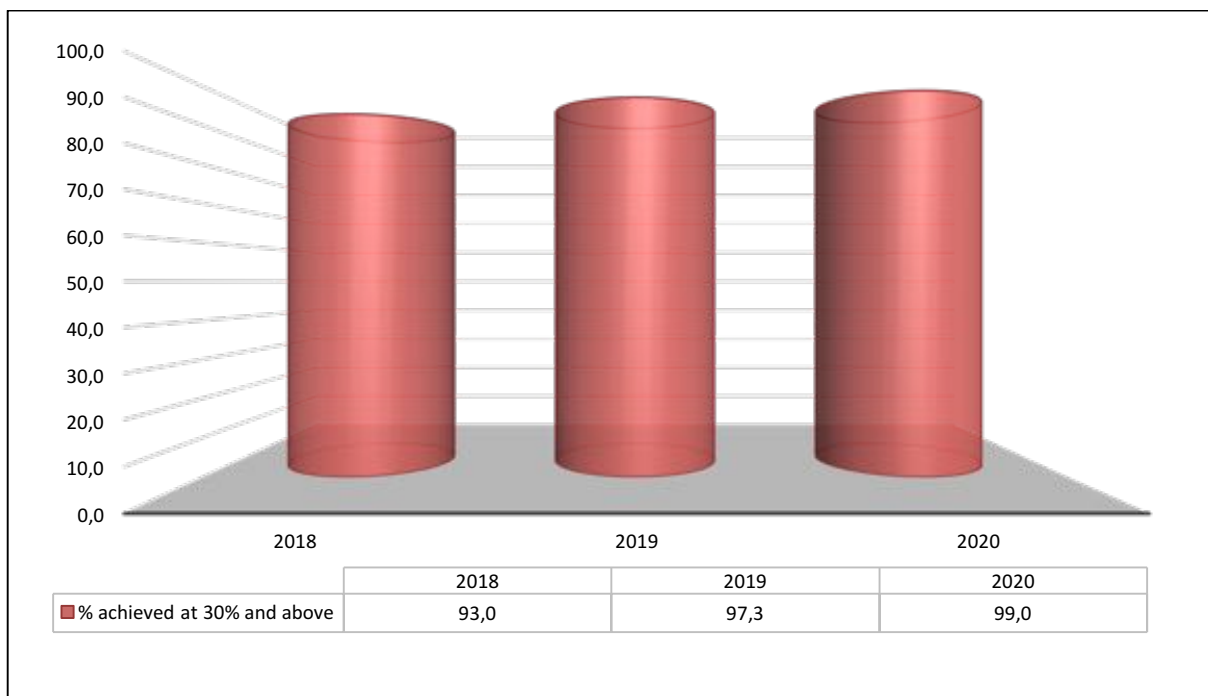
4.1.1 PERFORMANCE TRENDS (2018 - 2020)

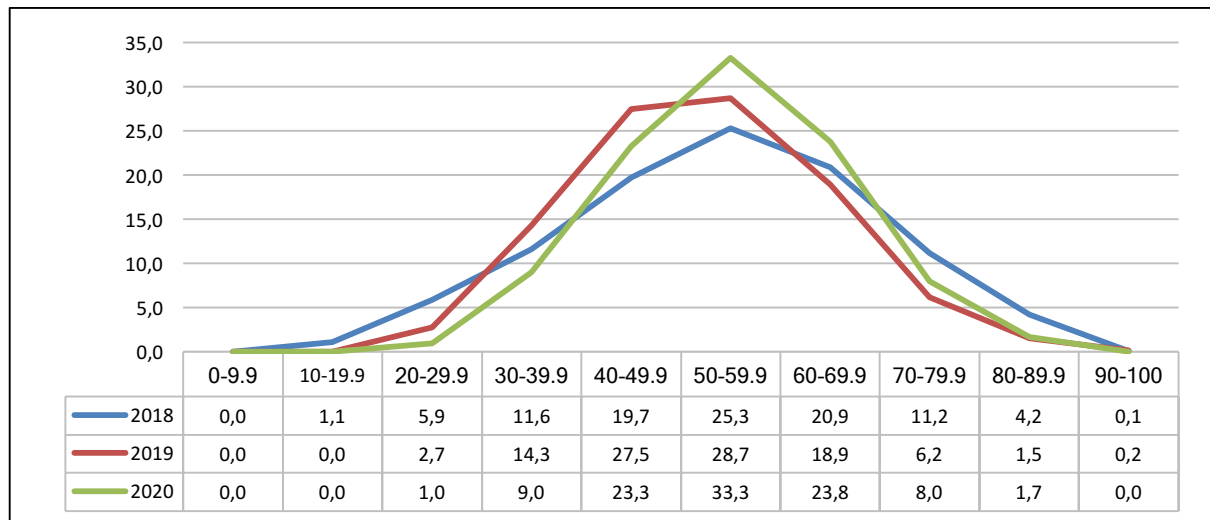
In 2020, 601 candidates sat for the Civil Services examination. The performance of the candidates in 2020 shows a marginal improvement compared to the performance in 2019.

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

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



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

4.1.2 OVERVIEW OF LEARNER PERFORMANCE IN THE CIVIL SERVICES PAPER

General comments

- (a) It was noted that many candidates did not start each question on a new page as indicated in the instructions.
- (b) A large number of candidates experienced difficulty with subject-specific and academic terminology. It is recommended that a glossary of academic terminology be compiled and given to learners and be used throughout the presentation of lessons. The meaning of each of these terms should be clearly explained to the learners.
- (c) Poor drawing and interpretation skills were evident. There was poor distinction between line diagrams, sketches, pictorial views and scale drawings. Many scale drawings were not done using drawing equipment.
- (d) From the responses in the scripts, it is evident that the candidates lacked practical exposure and experience.
- (e) It is imperative that labels be indicated on all drawings. A significant number of candidates were not credited due to a failure to indicate labels.
- (f) Candidates experienced challenges to express themselves when responding to questions which required them to describe or explain. It is important for learners to explain or describe concepts in a logical manner, e.g. 'Explain how to use a plastic plug to secure a bracket to a wall.'
- (g) Matching items and multiple-choice questions were left unanswered by some candidates and were not credited as a result. Learners should be encouraged to attempt to answer all these types of questions as no negative marking is applied.
- (h) Many candidates found it difficult to explain practical applications theoretically.

- (i) It is recommended that before they start with scale drawings, learners study the drawings by doing the drawing freehand until they know all the parts and the sequence to be followed.
- (j) In a question that counts 2 marks, a significant number of candidates provided only one response instead of two. Learners must be taught to derive the number of facts that they should state from the mark allocation of the question.
- (k) It is important that all topics be sufficiently covered before the preparatory examinations commence.
- (l) Teachers should not only rely on activities that are in the textbooks. Alternative questions that address the expected outcomes, as listed in the *CAPS* for all the topics, should be developed to cover all cognitive levels.
- (m) Learners must be aware that if the relevant unit of measurement is not stated in their answers in calculations, they may lose marks.

4.1.3 ANALYSIS OF LEARNER PERFORMANCE IN EACH QUESTION IN THE CIVIL SERVICES PAPER

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

Common errors and misconceptions

- (a) In Q1.1 (8 marks) candidates had difficulty with the matching-items question in linking the appropriate descriptions with the items provided. Candidates were not fully equipped to respond in the required manner. They had to demonstrate deeper insight in the properties and principles applied in materials and tools rather than the mere identification and use thereof. Many candidates were also not familiar with the correct subject terminology that was used in the question.
- (b) In Q1.4 (2 marks) candidates were not able to respond well to the question relating to the methods used to transport material and instead gave general answers related to handling of material.
- (c) In Q1.5 (2 marks) many candidates did not correctly identify the specific advantages of water-based paint; instead, they gave responses that were pertinent to paint in general.
- (d) In Q1.7 (3 marks) many candidates could not explain, using logical steps, how the fastener can be used to secure a bracket to a wall.

Suggestions for improvement

- (a) It is recommended that teachers ensure that learners fully understand the concepts related to materials and safety instead of rote learning. It is important that learners work physically with tools and equipment to become familiar with them and acquire the skill of using them. The challenges of answering this type of question can also be overcome by teaching learners how to select matching items by means of elimination.
- (b) It would be beneficial to learners if they are taught to read the question carefully and to isolate the exact aspect within the topic that should form the basis of their response.

- (c) Learners should be taught how to interpret and respond to this type of question. To assist in this regard, teachers should divide topics with a long list of possible answers into smaller sub-sections and group the relevant answers with the sub-topics during the teaching process.
- (d) More emphasis should be placed on the use of practical demonstrations of the application of different joining fixtures. Learners should be given the opportunity to practically use each of the prescribed joining fixtures during practical periods.

QUESTION 2: GRAPHICS AS METHOD OF COMMUNICATION

Common errors and misconceptions

- (a) Many candidates experienced challenges in reading and interpreting the floor plan and elevation and they were not able to identify and interpret drawing symbols.
- (b) Some candidates identified the elevations in Q2.1 (1 mark), Q2.13 (1 mark) and Q2.25 (2 marks) as front, top, or left view instead of north, east, south or west elevations.
- (c) Poor performance by candidates was noted in Q2.2 (1 mark) where the identification of a *double-storey* building posed a challenge to them.
- (d) In Q2.8 (1 mark) most candidates identified the component as a *downpipe* instead of a *downpipe shoe* or *shoe*.
- (e) In Q2.10 (1 mark) the majority of candidates were not able to state the correct meaning of the abbreviation *DPM* and confused the *damp-proof membrane* with *damp-proof course*.
- (f) Some candidates could not correctly state the purpose of the fascia board in Q2.14 (1 mark).
- (g) In Q2.15 (1 mark) many candidates were not able to deduce the features that were omitted on the plan.
- (h) In Q2.17 (1 mark) some candidates identified the water closet as a toilet.
- (i) In Q2.23 (1 mark) a significant number of candidates were not able to differentiate between the installation instructions of the brick force from the floor to the top of the window and from the top of the window to wall plate level, as indicated in the notes on the plan.
- (j) In Q2.29 (3 marks) most candidates were able to correctly calculate the area of the room.
- (k) In Q2.30 (6 marks) there was a noticeable improvement in responses from candidates who correctly deduced the dimensions of the wall thickness and room sizes from the correct elevation, correctly wrote them down next to one another and added the dimensions to obtain the total length of the wall.

Suggestions for improvement

- (a) Actual building plans should be used during teaching to familiarise learners with the interpretation of these items.
- (b) It is recommended that teachers differentiate between the elevations of a building and the views in orthographic drawings during teaching and also explain the correct use of the terminology in the correct context.
- (c) It will be beneficial to learners if teachers clearly distinguish between single-, double- and multi-storey buildings, as listed in the CAPS.
- (d) More analytical questions and worksheets, similar to Q2, should be done in class focusing on the correct terminology for each part on the drawings.
- (e) The SANS Code of Practice for Drawing Symbols should be used when teaching sections that require learners to draw or identify these symbols and abbreviations used in the building industry.
- (f) Teachers should develop worksheets comprising a schedule of all drawing symbols and abbreviations used in compiling/drafting of floor plans for learners to complete.
- (g) Teachers should not only teach learners what they see on the building plans, but also to identify/recognise all detail that should be indicated on a building plans as well as how to analyse and identify errors or omissions.
- (h) The correct use of subject terminology should be emphasised to ensure learners avoid unnecessary loss of marks through the use of incorrect terms.
- (i) Learners should be taught to read the whole question and to analyse instructions on a building plan in order to extract the relevant information.
- (j) It is recommended that teachers coach learners on how to convert the measurements given in millimetres to meters before they calculate the area.
- (k) 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 (5 marks) was poorly answered by most candidates. They were not familiar with the different soil types for the shoring required.
- (b) In Q3.3.3 (3 marks) many candidates were not familiar with the brick bond tested.
- (c) In Q3.4 (3 marks) most candidates were not familiar with the equipment '*respirator*' and wrote '*mask*' instead.
- (d) Many candidates had difficulty in drawing the sectional view of a manhole as required in Q3.6 (10 marks) correctly. This seemed to be because candidates had not been exposed to the specific practical aspects of building of this item.

- (e) In Q3.7 (8 marks) the majority of candidates demonstrated a poor understanding of the basic concepts in the calculation of volume and the correct use of the dimension sheet.

Suggestions for improvement

- (a) It is advised that subject advisors guide teachers in terms of the application of the different types of shoring in different soil types. Pictures and video clips can be used to enhance the understanding of the application of shoring in a real-life context.
- (b) It will be beneficial to learners if they are exposed to the practical dry packing of the different brick bonds. Learners should also perform freehand drawings of the different brick bonds indicating the sizes of the different bricks used.
- (c) It is recommended that teachers emphasise the correct terminology of equipment during teaching and informal assessment.
- (d) It is advised that learners be allowed to build a manhole in groups during practical periods using sand and building lime for mortar to enable them to properly experience and understand how a manhole is built and how it works.
- (e) Subject advisors should conduct workshops on the calculation of quantities. It is further recommended that teachers develop a significant number of exercises where learners will be required to calculate volume. Civil Services teachers should not rely on the Mathematics teachers to cover this section of work but should ensure that learners are exposed to these types of calculations in the Civil Technology class.

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

Common errors and misconceptions

- (a) In Q4.1 (6 marks) most candidates had difficulty with the drawing of the sectional view of the open and closed non-return valve.
- (b) In Q4.3 (2 marks) many candidates were not able to explain what soil water is.
- (c) The identification of common pipe joints, pipes and fittings used in a drainage system in Q4.4 (3 marks) posed a challenge for many candidates.
- (d) In Q4.5 (1 mark) most candidates were not familiar with the testing apparatus that was tested and could not state the correct name of the tool.
- (e) The selection of the correct couplings to repair leaking galvanised pipes posed a challenge for many candidates.
- (f) In Q4.8.1 (2 marks) and Q4.8.2 (4 marks), the analysis and identification of faults in the geyser installation proved to be challenging for many candidates and they were not able to recommend solutions to the faults in the system.
- (g) Most candidates were not familiar with the different parts of the solar heating unit in Q4.9.2 (4 marks).

- (h) In Q4.12 (2 marks) many candidates gave general responses to the use of the drain cleaning machine and drain rods instead of differentiating between the two in terms of the effort by the worker.
- (i) Most candidates experienced challenges in stating the measures to consider when taking care of the bearings of a centrifugal pump in Q4.13 (2 marks).

Suggestions for improvement

- (a) It is advised that a practically orientated teaching methodology be used for the teaching of this topic. It will benefit learners if teachers can realistically show the parts and working principles of the valves.
- (b) It is recommended that teachers differentiate between soil and wastewater using a table so that learners can clearly identify the differences between the two.
- (c) A practical demonstration will help to develop a better understanding of the different pipe fittings and where they are used.
- (d) Learners will benefit if informal assessment tasks are conducted on a regular basis during each term to test the identification of tools and equipment as well as the correct terminology that is required.
- (e) The challenges in this topic can be addressed by allowing learners to do practical maintenance on pipework using different types of joints. The difficulties experienced by learners regarding their knowledge of pipe fittings can be addressed by using practical demonstrations of the different pipe fittings to show the placement and use in a system.
- (f) It will be beneficial to learners if the different systems as listed in the curriculum are demonstrated practically incorporating missing or wrongly placed items so that learners can practically manage fault-finding and recommend the correct measures to rectify the identified problems.
- (g) A practical demonstration will help learners to develop a better understanding of the different parts of solar heating units. In the absence of examples of real solar heating units, animated video clips can be used effectively to make the concepts more understandable to learners.
- (h) It is recommended that teachers guide learners in identifying the key aspects that should be differentiated within a question when attempting to answer this type of question.
- (i) A possible cause of the inability of learners to state aspects that should be taken into consideration when taking care of the bearings of a centrifugal pump might be that they have not seen a centrifugal pump being taken apart. They might also not know what a bearing is. Practical demonstrations and animated video clips can be used to overcome this challenge.

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

Common errors and misconceptions

- (a) In Q5.4 (5 marks) most candidates were not able to draw the stop end of a gutter as expected.
- (b) Many candidates were not able to explain the purpose of a stop end on a gutter in Q5.5 (1 mark).
- (c) Poor performance was evident in the drawing of the development of the pyramid in Q5.7 (19 marks). Many candidates could not determine the true length of the sides of the pyramid and could therefore not draw the development correctly. Some candidates experienced challenges regarding the starting point of the development and started at a corner instead of the middle of the side where the seam was indicated.
- (d) Many candidates did not show construction lines on the drawing.

Suggestions for improvement

- (a) It will benefit learners if a sample of a stop end of a gutter is made available in class so that learners can draw a freehand sketch of exactly what they see.
- (b) It is recommended that the different parts of gutters are taught using a practical teaching approach with real gutters as examples.
- (c) Workshops on the development of cones and pipes, conducted by subject specialists, will benefit teachers. Making paper or cardboard models of the developments listed in the CAPS will assist learners in their understanding of these concepts. Learners should be taught to use the assessment criteria provided to guide them when drawing the developments.
- (d) More emphasis should be placed on the importance of good drawing techniques, e.g. showing all construction lines on drawings.

QUESTION 6: SEWERAGE, SANITARY FITTINGS AND JOINING

Common errors and misconceptions

- (a) In Q6.2 (2 marks) most candidates were not able to correctly identify the pipe joints as illustrated, nor were they able to indicate where these joints are used.
- (b) Most candidates experienced difficulty in expressing themselves in a logical manner in describing the purpose of the overflow of the bath in Q6.3.1 (2 marks).
- (c) In Q6.5 (14 marks) many candidates had difficulty with the drawing of the sewerage layout that was required. 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.
- (d) Candidates were not familiar with the purpose of a septic tank in Q6.8 (1 mark).

Suggestions for improvement

- (a) It will benefit learners to physically use the prescribed joints and to be exposed to a sectional view of the real joints. This will enhance their understanding of the different joints and develop their skills in the drawing of these items.
- (b) It is recommended that learners be given the opportunity in class to explain different concepts and principles in the language of teaching and learning to develop their ability to express themselves in a logical manner.
- (c) 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 this topic.
- (d) It will benefit learners if teachers practically demonstrate the working principles and purpose of septic tanks and conservancy tanks. A clear distinction should be made between the two systems.

4.2 CONSTRUCTION

The following report should be read in conjunction with the Construction question paper of the November 2020 Examinations.

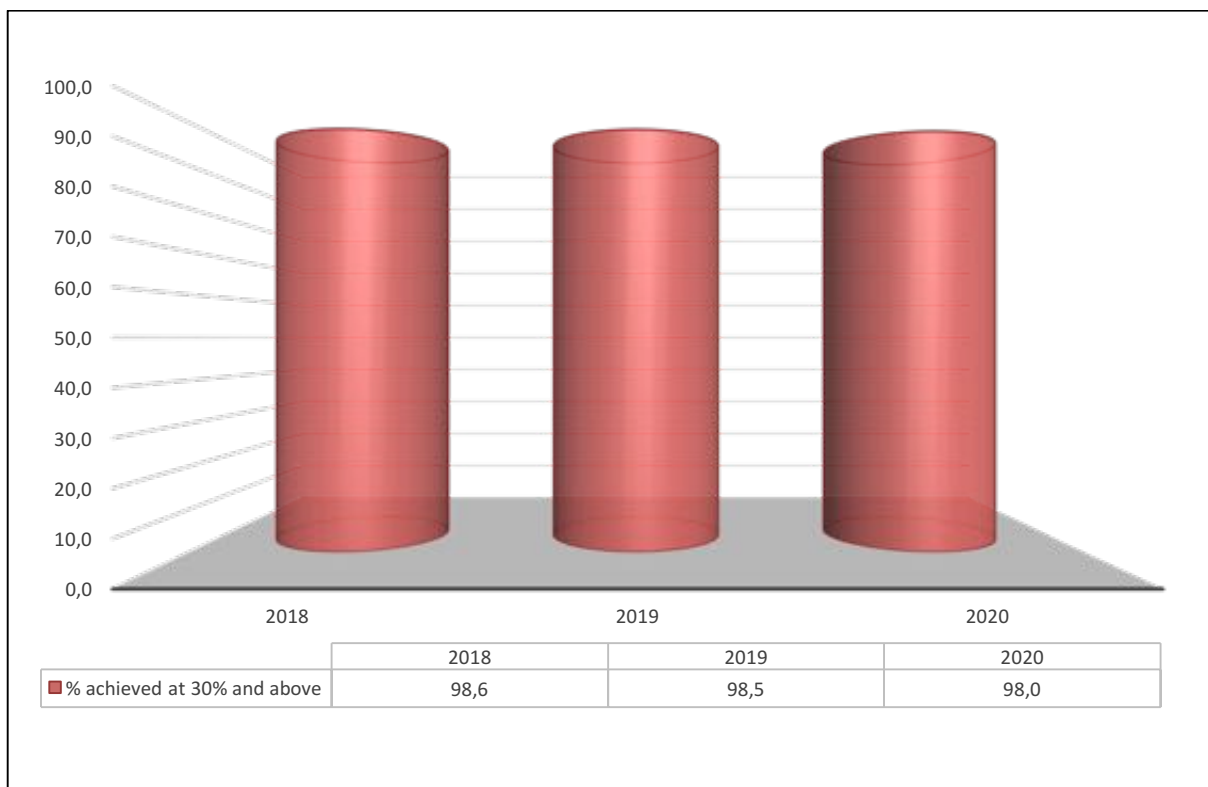
4.2.1 PERFORMANCE TRENDS (2018 - 2020)

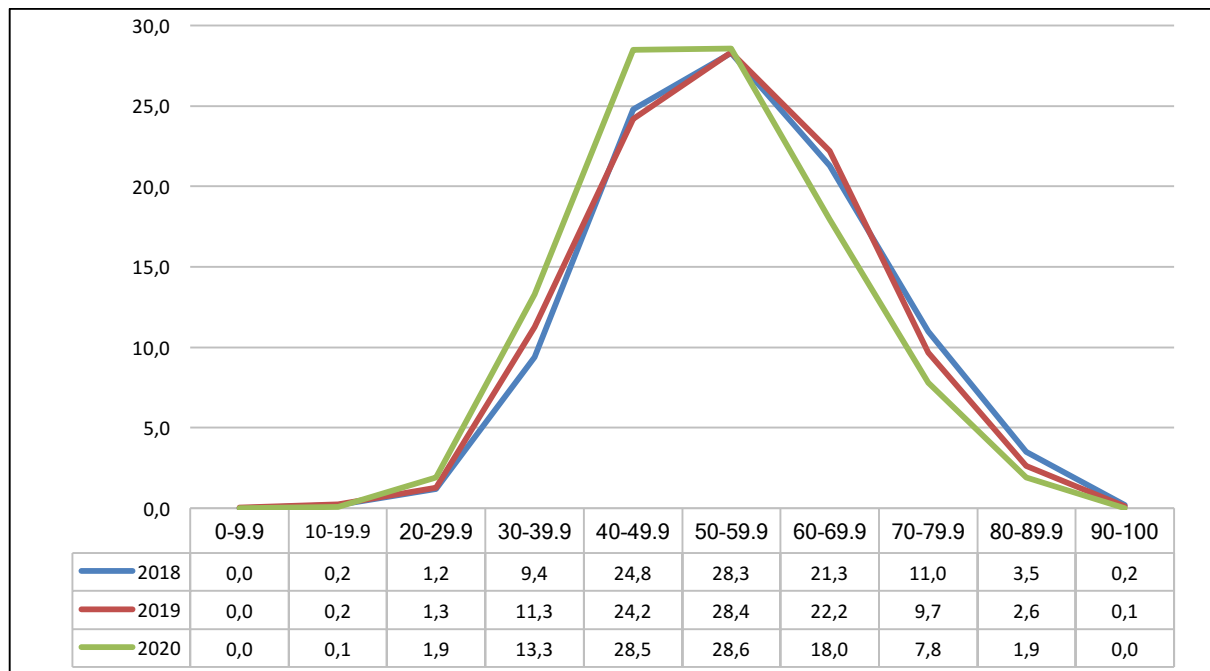
In 2020, 3 582 candidates sat for the Construction examination. There was a slight increase in the number of learners taking the subject in 2020. The performance of the candidates in 2020 was close to the performance of learners in 2019.

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

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



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

4.2.2 OVERVIEW OF LEARNER PERFORMANCE IN THE CONSTRUCTION PAPER

General comments

- It was noted that many candidates did not start each question on a new page as indicated in the instructions.
- A large number of candidates experienced difficulty with subject-specific and academic terminology. It is recommended that a glossary of academic terminology be compiled and given to learners and be used throughout the presentation of lessons. The meaning of each of these terms should be clearly explained to the learners.
- Poor drawing and interpretation skills were evident. There was poor distinction between line diagrams, sketches, pictorial views and scale drawings. Many scale drawings were not done using drawing equipment.
- From the responses in the scripts, it is evident that the candidates lacked practical exposure and experience.
- It is imperative that labels be indicated on all drawings. A significant number of candidates were not credited due to a failure to indicate labels.
- Candidates experienced challenges to express themselves when responding to questions which required them to describe or explain. It is important for learners to explain or describe concepts in a logical manner, e.g. 'Explain how to use a plastic plug to secure a bracket to a wall'.

- (g) Matching items and multiple-choice questions were left unanswered by some candidates and were not credited as a result. Learners should be encouraged to attempt to answer all these types of questions as no negative marking is applied.
- (h) Many candidates found it difficult to explain practical applications theoretically.
- (i) It is recommended that before they start with scale drawings, learners study the drawings by doing the drawing freehand until they know all the parts and the sequence to be followed.
- (j) In a question that counts 2 marks, a significant number of candidates provided only one response instead of two. Learners must be taught to derive the number of facts that they should state from the mark allocation of the question.
- (k) It is important that all topics be sufficiently covered before the preparatory examinations commence.
- (l) Teachers should not rely only on activities that are in the textbooks. Alternative questions that address the expected outcomes, as listed in the *CAPS* for all the topics, should be developed to cover all cognitive levels.
- (m) Learners must be aware that if the relevant unit of measurement is not stated in their answers in calculations, they may lose marks.

4.2.3 ANALYSIS OF LEARNER PERFORMANCE IN EACH QUESTION IN THE CONSTRUCTION PAPER

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

Common errors and misconceptions

- (a) In Q1.1 (8 marks) candidates had difficulty with the matching-items question in linking the appropriate descriptions with the items provided. Candidates were not fully equipped to respond in the required manner. They had to demonstrate deeper insight in the properties and principles applied in materials and tools rather than the mere identification and use thereof. Many candidates were also not familiar with the correct subject terminology that was used in the question.
- (b) In Q1.4 (2 marks) candidates were not able to respond well to the question relating to the methods used to transport material and instead gave general answers related to handling of material.
- (c) In Q1.5 (2 marks) many candidates did not correctly identify the specific advantages of water-based paint; instead, they gave responses that were pertinent to paint in general.
- (d) In Q1.7 (3 marks) many candidates could not explain, in logical steps, how the fastener can be used to secure a bracket to a wall.

Suggestions for improvement

- (a) It is recommended that teachers ensure that learners fully understand the concepts related to materials and safety instead of rote learning. It is important that learners work physically with tools and equipment to become familiar with them and acquire the skill of using them. The challenges of answering this type of question can also be overcome by teaching learners how to select matching items by means of elimination.
- (b) It would be beneficial to learners if they are taught to read the question carefully and to isolate the exact aspect within the topic that should form the basis of their response.
- (c) Learners should be taught how to interpret and respond to this type of question. To assist in this regard, teachers should divide topics with a long list of possible answers into smaller sub-sections and group the relevant answers with the sub-topics during the teaching process.
- (d) More emphasis should be placed on the use of practical demonstrations of the application of different joining fixtures. Learners should be given the opportunity to practically use each of the prescribed joining fixtures during practical periods.

QUESTION 2: GRAPHICS AS METHOD OF COMMUNICATION

Common errors and misconceptions

- (a) Many candidates experienced challenges in reading and interpreting the floor plan and elevation and they were not able to identify and interpret drawing symbols.
- (b) Some candidates identified the elevations in Q2.1 (1 mark), Q2.13 (1 mark) and Q2.25 (2 marks) as front, top, or left view instead of north, east, south or west elevations.
- (c) Poor performance by candidates was noted in Q2.2 (1 mark) where the identification of a *double-storey* building posed a challenge to them.
- (d) In Q2.8 (1 mark) most candidates identified the component as a *downpipe* instead of a *downpipe shoe or shoe*.
- (e) In Q2.10 (1 mark) the majority of candidates were not able to state the correct meaning of the abbreviation *DPM* and confused the *damp-proof membrane* with *damp-proof course*.
- (f) Some candidates could not correctly state the purpose of the fascia board in Q2.14 (1 mark).
- (g) In Q2.15 (1 mark) many candidates were not able to deduce the features that were omitted on the plan.
- (h) In Q2.17 (1 mark) some candidates identified the water closet as a toilet.
- (i) In Q2.23 (1 mark) a significant number of candidates were not able to differentiate between the installation instructions of the brick force from the floor to the top of the window and from the top of the window to wall plate level as indicated in the notes on the plan.
- (j) In Q2.29 (3 marks) most candidates were able to correctly calculate the area of the room.

- (k) In Q2.30 (6 marks) there was a noticeable improvement in responses from candidates who correctly deduced the dimensions of the wall thickness and room sizes from the correct elevation, correctly wrote them down next to one another and added the dimensions to obtain the total length of the wall.

Suggestions for improvement

- (a) Actual building plans should be used during teaching to familiarise learners with the interpretation of these items.
- (b) It is recommended that teachers differentiate between the elevations of a building and the views in orthographic drawings during teaching and also explain the correct use of the terminology in the correct context.
- (c) It will be beneficial to learners if teachers clearly distinguish between single-, double- and multi-storey buildings, as listed in the *CAPS*.
- (d) More analytical questions and worksheets, similar to Q2, should be done in class focusing on the correct terminology for each part on the drawings.
- (e) The SANS Code of Practice for Drawing Symbols should be used when teaching sections that require learners to draw or identify these symbols and abbreviations used in the building industry.
- (f) Teachers should develop worksheets comprising a schedule of all drawing symbols and abbreviations used in compiling/drafting of floor plans for learners to complete.
- (g) Teachers should not only teach learners what they see on the building plans, but also to identify/recognise all detail that should be indicated on a building plans as well as how to analyse and identify errors or omissions.
- (h) The correct use of subject terminology should be emphasised to ensure learners avoid unnecessary loss of marks through the use of incorrect terms.
- (i) Learners should be taught to read the whole question and to analyse instructions on a building plan in order to extract the relevant information.
- (j) It is recommended that teachers coach learners on how to convert the measurements given in millimetres to metres before they calculate the area.
- (k) 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) It was observed that many candidates were not able to recall the terminology, angles, or diameter of the roof in Q3.1.1 to Q3.1.5 (5 marks).
- (b) Candidates struggled to differentiate between different action words. For example, in Q3.2 (1 mark) they were expected to name principles but listed functions instead.
- (c) In Q3.6 (9 marks) most candidates attempted to draw the roof truss but could not correctly complete the joint to the wall using a hoop-iron strap.

- (d) Candidates struggled to draw the components of a roof truss to scale in Q3.7 (8 marks). Candidates did not adhere to or apply the prescribed scale.

Suggestions for improvement

- (a) It is recommended that samples of roof members be given to learners so that they gain practice in drawing the members to the actual size and in indicating the dimensions and labels on the drawings.
- (b) Different action words should be used during formal and informal assessments so that learners can familiarise themselves with these words and what is expected from different questions.
- (c) More detailed presentations on the different parts of a roof truss should be done to prepare learners to answer drawing questions on roof trusses. Learners should also be exposed to different types of drawings related to roof trusses and not just the standard roof trusses.
- (d) It is recommended that teachers provide learners with more exercises on the drawing of roof trusses for learners to 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 Q4.4 (1 mark) candidates were not able to identify the part of the formwork that will be dismantled first.
- (b) Many candidates could not name a material that can be used to fix cladding to a wall in Q4.10 (1 mark).
- (c) Poor performance was noticed in Q4.15 (14 marks) due to a lack of content knowledge in formwork. Most candidates were not able to draw the necessary detail that was requested from them. It is also noted that candidates did not follow the assessment criteria given to them on the answer sheet.

Suggestions for improvement

- (a) It is important that learners get to experience using, erecting, and dismantling formwork during practical periods. This will enable learners to comprehend the working procedures of formwork better.
- (b) These topics should be emphasised in greater detail and the focus should not only be on diagrams and drawings but also on the different types of materials that are used.
- (c) A model of the formwork for concrete stairs will assist learners in gaining a better understanding of formwork and the different parts thereof. Assessment criteria should be used in informal and formal assessment tasks to better prepare learners for NSC questions that demand this.

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

Common errors and misconceptions

- (a) In Q5.1.1 (1 mark) and Q5.1.2 (1 mark), many candidates were not familiar with different types of finishes that can be obtained with different methods or machinery. Candidates limited themselves to identifying finishes without stating the finishes obtained by different methods.
- (b) In Q5.5 (2 marks) many candidates had difficulty to differentiate between a rough arch and a gauged arch in terms of the shapes of the mortar joints.
- (c) Q5.6 was poorly answered. Most candidates are not able to draw the alternate plan courses of brick walls (10 marks). Many candidates found it difficult to see, interpret and draw the different courses of brick walls.
- (d) In Q5.7 (12 marks) only a few candidates correctly drew the horizontal section through a wooden door frame built into a wall. Some candidates drew a vertical section while others struggled to do this to a scale of 1:10.

Suggestions for improvement

- (a) Teaching this topic should not be limited only to the illustrations in textbooks. It would be beneficial to have videos that show the finishing methods. Alternatively, if the machinery and tools are available, learners could experience this topic during practical periods.
- (b) Teaching arches should not only be limited to discussions and pictures. If learners draw these diagrams regularly, they will tend to identify shapes more easily.
- (c) Learners should 'dry-pack' a few consecutive courses of different types of walls in different types of bonds to enhance their understanding of the topic. If the space is limited or full-sized bricks are not available, the teacher could make wooden blocks to a smaller scale and learners can then practise packing them on their school desks.
- (d) More emphasis should be placed on the different orientations of sectional drawings for door frames. The conversion of different scales should be practised often so that the learners will understand how to draw to different scales.

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

Common errors and misconceptions

- (a) Candidates tended to become confused when given different options in Q 6.1.1 to Q6.1.5 (5 marks). This was mainly because they did not know the content well enough and this posed a significant challenge for them.
- (b) In Q6.2 (5 marks) candidates struggled to make a detailed drawing of the installation of a driven in-situ pile.
- (c) In Q6.5 (7 marks) many candidates were not able to draw a sectional view of a round reinforced concrete column. Most candidates drew a square column and many of them

did not indicate eight main bars. The drawings offered by candidates suggested that they had replicated a drawing of this nature from one of the previous question papers.

- (d) Doing basic calculations posed a serious challenge to candidates. Many candidates could not calculate the correct area of the floor, the volume of concrete or the number of tiles needed in Q6.6.1 to Q6.6.3 (12 marks). Most candidates could not use the dimension paper on the answer sheet for Q6.6 correctly.

Suggestions for improvement

- (a) Reinforcement is a topic that is covered from Grade 10. Topics such as these that are repeated in the curriculum should not simply be revised in Grade 12. Every topic should be covered intensely in Grade 12 to ensure that learners recall these facts during formal assessments.
- (b) It is recommended that these types of drawings be drawn during class time. 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 to demonstrate these installations.
- (c) Learners should use previous question papers for revision. While these provide valuable enrichment, teachers need to impress upon learners that they should not only study previous papers but should also extend their knowledge from a variety of sources. Questions should not simply be repeated in different examinations since it gives the incorrect impression to learners that they need only focus on certain drawings or topics.
- (d) More exercises on the calculation of quantities of materials for a building should be given to learners to develop a better understanding of the topic. These calculations should always be done on dimension paper so that learners become familiar with this process in 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 2020 Examinations.

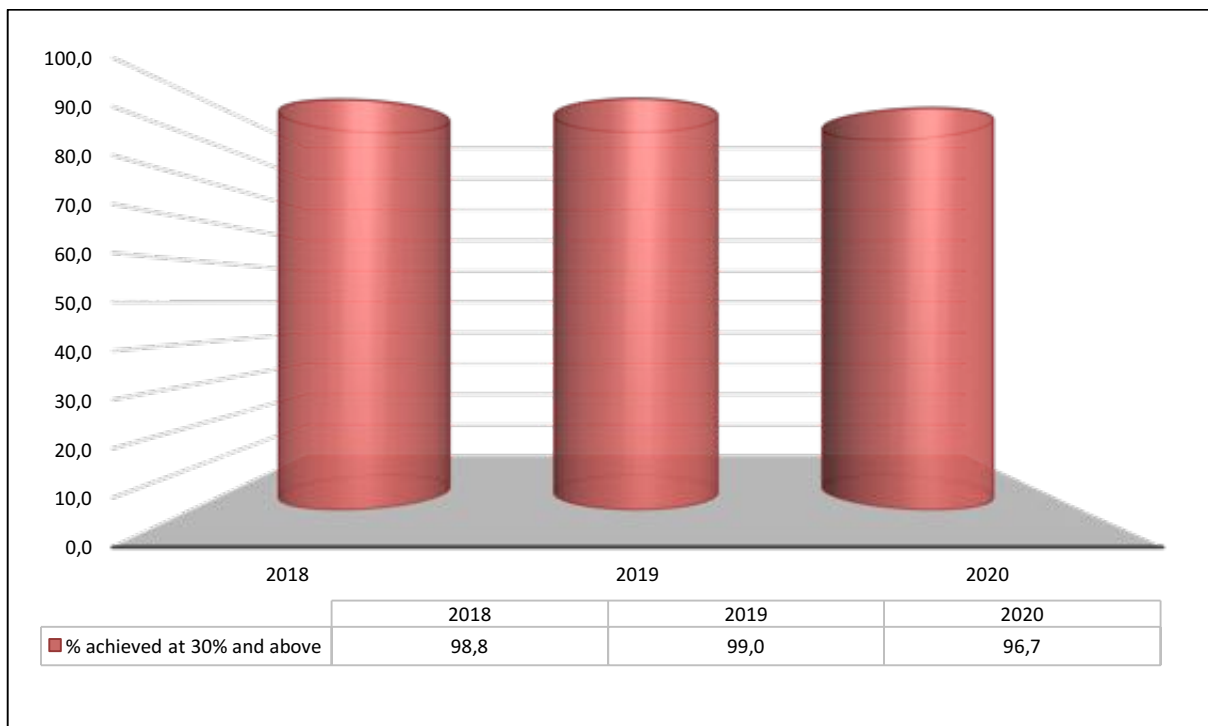
4.3.1 PERFORMANCE TRENDS (2018 - 2020)

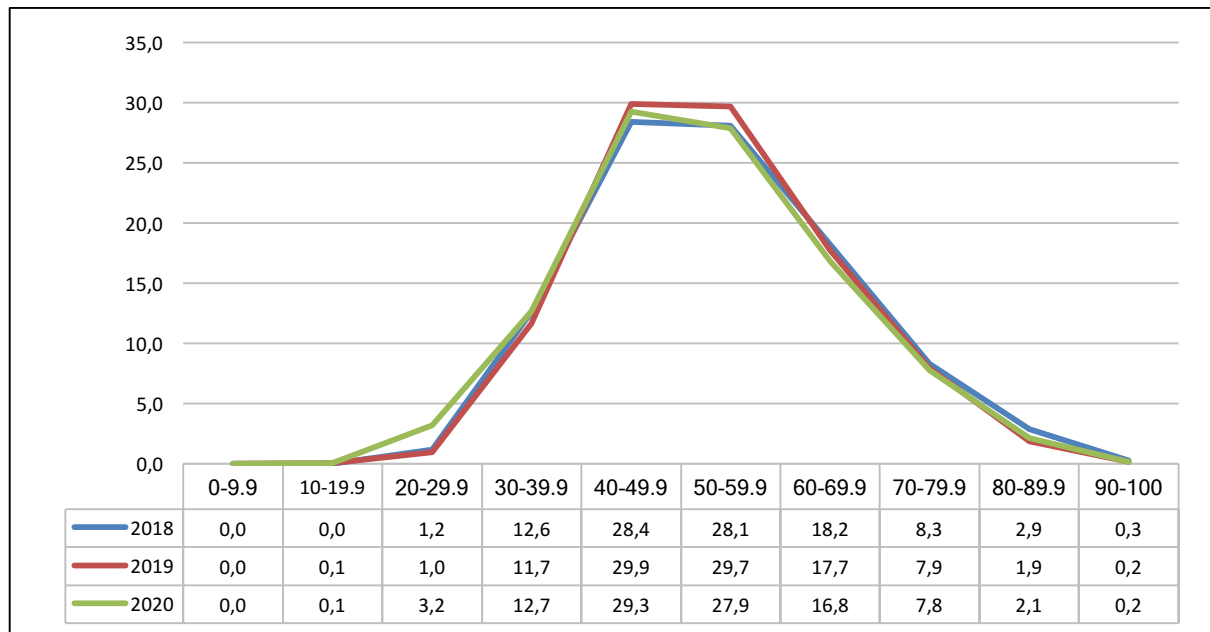
In 2020, 1 837 candidates sat for the Woodworking examination. The performance of the candidates in 2020 shows a decline when compared to the performance in 2019.

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

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



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

4.3.2 OVERVIEW OF LEARNER PERFORMANCE IN THE WOODWORKING PAPER

General comments

- (a) It was noted that many candidates did not start each question on a new page as indicated in the instructions.
- (b) A large number of candidates experienced difficulty with subject-specific and academic terminology. It is recommended that a glossary of academic terminology be compiled and given to learners and be used throughout the presentation of lessons. The meaning of each of these terms should be clearly explained to the learners.
- (c) Poor drawing and interpretation skills were evident. There was poor distinction between line diagrams, sketches, pictorial views and scale drawings. Many scale drawings were not done using drawing equipment.
- (d) From the responses in the scripts, it is evident that the candidates lacked practical exposure and experience.
- (e) It is imperative that labels be indicated on all drawings. A significant number of candidates were not credited due to a failure to indicate labels.
- (f) Candidates experienced challenges to express themselves when responding to questions which required them to describe or explain. It is important for learners to explain or describe concepts in a logical manner, e.g. 'Explain how to use a plastic plug to secure a bracket to a wall'.
- (g) Matching items and multiple-choice questions were left unanswered by some candidates and were not credited as a result. Learners should be encouraged to attempt to answer all these types of questions as no negative marking is applied.

- (h) Many candidates found it difficult to explain practical applications theoretically.
- (i) It is recommended that before they start with scale drawings, learners study the drawings by doing the drawing freehand until they know all the parts and the sequence to be followed.
- (j) In a question that counts 2 marks, a significant number of candidates provided only one response instead of two. Learners must be taught to derive the number of facts that they should state from the mark allocation of the question.
- (k) It is important that all topics be sufficiently covered before the preparatory examinations commence.
- (l) Teachers should not only rely on activities that are in the textbooks. Alternative questions that address the expected outcomes, as listed in the *CAPS* for all the topics, should be developed to cover all cognitive levels.
- (m) Learners must be aware that if the relevant unit of measurement is not stated in their answers in calculations, they may lose marks.

4.3.3 ANALYSIS OF LEARNER PERFORMANCE IN EACH QUESTION IN THE WOODWORKING PAPER

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

Common errors and misconceptions

- (a) In Q1.1 (8 marks) candidates had difficulty in the matching-items question in linking the appropriate descriptions with the items provided. Candidates were not fully equipped to respond in the required manner. They had to demonstrate deeper insight in the properties and principles applied in materials and tools rather than the mere identification and use thereof. Many candidates were also not familiar with the correct subject terminology that was used in the question.
- (b) In Q1.4 (2 marks) candidates were not able to respond well to the question relating to the methods used to transport material and instead gave general answers related to handling of material.
- (c) In Q1.5 (2 marks) many candidates did not correctly identify the specific advantages of water-based paint; instead, they gave responses that were pertinent to paint in general.
- (d) In Q1.7 (3 marks) many candidates could not explain in logical steps how the fastener can be used to secure a bracket to a wall.

Suggestions for improvement

- (a) It is recommended that teachers ensure that learners fully understand the concepts related to materials and safety instead of rote learning. It is important that learners work physically with tools and equipment to become familiar with them and acquire the skill of using them. The challenges of answering this type of question can also be overcome by teaching learners how to select matching items by means of elimination.

- (b) It would be beneficial to learners if they are taught to read the question carefully and to isolate the exact aspect within the topic that should form the basis of their response.
- (c) Learners should be taught how to interpret and respond to this type of question. To assist in this regard, teachers should divide topics with a long list of possible answers into smaller sub-sections and group the relevant answers with the sub-topics during the teaching process.
- (d) More emphasis should be placed on the use of practical demonstrations of the application of different joining fixtures. Learners should be given the opportunity to practically use each of the prescribed joining fixtures during practical periods.

QUESTION 2: GRAPHICS AS METHOD OF COMMUNICATION

Common errors and misconceptions

- (a) Many candidates experienced challenges in reading and interpreting the floor plan and elevation and they were not able to identify and interpret drawing symbols.
- (b) Some candidates identified the elevations in Q2.1 (1 mark), Q2.13 (1 mark) and Q2.25 (2 marks) as front, top, or left view instead of north, east, south or west elevations.
- (c) Poor performance by candidates was noted in Q2.2 (1 mark) where the identification of a *double-storey* building posed a challenge to them.
- (d) In Q2.8 (1 mark) most candidates identified the component as a *downpipe* instead of a *downpipe shoe* or *shoe*.
- (e) In Q2.10 (1 mark) the majority of candidates were not able to state the correct meaning of the abbreviation *DPM* and confused the *damp-proof membrane* with *damp-proof course*.
- (f) Some candidates could not correctly state the purpose of the fascia board in Q2.14 (1 mark).
- (g) In Q2.15 (1 mark) many candidates were not able to deduce the features that were omitted on the plan.
- (h) In Q2.17 (1 mark) some candidates identified the water closet as a toilet.
- (i) In Q2.23 (1 mark) a significant number of candidates were not able to differentiate between the installation instructions of the brick force from the floor to the top of the window and from the top of the window to wall plate level as indicated in the notes on the plan.
- (j) In Q2.29 (3 marks) most candidates were able to correctly calculate the area of the room.
- (k) In Q2.30 (6 marks) there was a noticeable improvement in responses from candidates who correctly deduced the dimensions of the wall thickness and room sizes from the correct elevation, correctly wrote them down next to one another and added the dimensions to obtain the total length of the wall.

Suggestions for improvement

- (a) Actual building plans should be used during teaching to familiarise learners with the interpretation of these items.
- (b) It is recommended that teachers differentiate between the elevations of a building and the views in orthographic drawings during teaching and also explain the correct use of the terminology in the correct context.
- (c) It will be beneficial to learners if teachers clearly distinguish between single-, double- and multi-storey buildings, as listed in the *CAPS*.
- (d) More analytical questions and worksheets, similar to Q2, should be done in class focusing on the correct terminology for each part on the drawings.
- (e) The SANS Code of Practice for Drawing Symbols should be used when teaching sections that require learners to draw or identify these symbols and abbreviations used in the building industry.
- (f) Teachers should develop worksheets comprising a schedule of all drawing symbols and abbreviations used in compiling/drafting of floor plans for learners to complete.
- (g) Teachers should not only teach learners what they see on the building plans, but also to identify/recognise all detail that should be indicated on a building plans as well as how to analyse and identify errors or omissions.
- (h) The correct use of subject terminology should be emphasised to ensure learners avoid unnecessary loss of marks through the use of incorrect terms.
- (i) Learners should be taught to read the whole question and to analyse instructions on a building plan in order to extract the relevant information.
- (j) It is recommended that teachers coach learners on how to convert the measurements given in millimetres to meters before they calculate the area.
- (k) 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 Q3.2 (4 marks) it was evident from the responses of many candidates that they were unable to correctly draw a vertical section through a transom of a casement frame with fanlight.
- (b) In Q3.4 (4 marks) only a few candidates drew the horizontal section view of the bottom part of a wall panel showing how the strip boards are joined. Many candidates could not differentiate between a horizontal and a vertical section and hence drew the wrong section.
- (c) In Q3.5.1 (4 marks) most candidates experienced challenges to calculate the length of fascia board needed for the roof.

- (d) In Q3.5.2 (4 marks) most candidates experienced challenges in calculating the length of skirting needed for the garage. Candidates demonstrated poor skills in the use of the dimension paper and in many cases, did not know where to start with this calculation.

Suggestions for improvement

- (a) It is recommended that an old casement with a fanlight, which is not being used, should be cut and the relevant sections shown to the learners in class. The learners should then make drawings of what they see in the model.
- (b) It will be beneficial to learners if they are exposed to more horizontal and vertical drawings on content related to woodworking. This will enable learners to distinguish between vertical and horizontal sectional views.
- (c) Practical exercises in measuring will allow the learners to measure the inside as well as the outside of a building which will ensure that they understand the difference between internal and external measurements.
- (d) 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 the correct positions of materials in a building.

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

Common errors and misconceptions

- (a) In Q4.1.1 (1 marks) many candidates could not identify the portable belt sander correctly.
- (b) In Q4.1.2 (2 marks) the majority of candidates were not able to describe what will happen if no personal safety equipment is worn.
- (c) In Q4.2.1 (2 marks) many candidates could not explain what would happen if the height of the table is adjusted while the machine is in operation.
- (d) In Q4.3 (3 marks) a significant number of candidates were not able to differentiate between the different types of roof underlays.
- (e) Most candidates had difficulty to describe the disadvantages of the different roof coverings in Q4.7 (6 marks)
- (f) In Q4.11 (12 marks) many candidates struggled to draw to scale the components of a king post roof truss. Candidates did not adhere to the prescribed scale.

Suggestions for improvement

- (a) Learners should be given more practical exposure to all the listed tools and equipment prescribed in the CAPS in order to familiarise themselves with the parts, proper use, care and safety of machines.
- (b) Off-cuts from roof truss manufacturers should be obtained and learners should measure these to become familiar with their sizes and scales.

- (c) Examples of different types of roof coverings should be made available and used during the teaching of these topics to show the actual features of the roof coverings for different types of roofs.
- (d) Models of the different types of roof trusses should be made available in the workshop. Learners must make freehand sketches of these roof trusses. When they have acquired the skill of drawing the roof trusses freehand, they should progress to making scale drawings of the trusses.
- (e) It is recommended that practical examples of different roof coverings be used to enhance teaching so that learners can feel and see the properties of the different types of roof covering.
- (f) More emphasis should be placed on the correct use of drawing equipment and the standard of drawings from Grade 10 onwards to ensure that learners develop the correct drawing skills and are able to demonstrate these skills by the end of Grade 12.

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

Common errors and misconceptions

- (a) Many candidates were not able to identify the constructional detail at the foot of a centre in Q5.1 (5 marks).
- (b) In Q5.4 (4 marks) the majority of candidates were not able to identify two possible mistakes in the construction of the dead shore. Consequently, they could also not recommend possible solutions to rectify the mistakes.
- (c) Most candidates were not able to differentiate by means of two line diagrams between a couple roof truss and a collar-tie roof truss as required in Q5.5 (8 marks).
- (d) In Q5.6 (9 marks) many candidates were not able to draw a vertical section through the formwork for an in-situ cast concrete floor correctly.

Suggestions for improvement

- (a) Part of a rib with laggings should be used during lessons to show the difference between *closed laggings* and *open laggings*.
- (b) A model of the dead shore can be constructed to enable learners to be able to identify the different parts as well as the layout. This will improve their understanding of the use and purpose of the dead shore.
- (c) Models of the different types of roof trusses will assist learners to gain a better understanding of the layout of various roof truss types.
- (d) A model should be made in the workshop for all concrete structures requiring formwork that are listed in the *CAPS*. It must be explained to learners why each component of the formwork is placed at a particular point, its position and the purpose that the component serves.

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

Common errors and misconceptions

- (a) In Q6.2 (4 marks) many candidates were not able to identify parts of a suspended timber floor.
- (b) Most candidates could not draw the top view of part of the layout of the upper level of the suspended floor in Q6.3 (3 marks) to show how the struts are staggered.
- (c) In Q6.7 (6 marks) many candidates experienced difficulties with drawing a vertical section through a lock rail as well as with drawing part of the raised panels of a three-panel door.
- (d) In Q6.9.2 (5 marks) the majority of candidates were not able to draw the sectional view of the bottom part of a framed ledged and braced batten door.
- (e) A significant number of candidates could not draw a line diagram of the top view of a straight flight of stairs with a landing between the steps in Q6.10 (8 marks).

Suggestions for improvement

- (a) The use of a model of a suspended timber floor showing all components, including the supporting piers, will assist learners with gaining a better understanding of a suspended timber floor.
- (b) It would benefit learners to make a small model of the staggered joints of the suspended floor to enable them to understand the concept properly.
- (c) A model of a three-panel door with raised panels and framed ledged and braced batten door should be made in the workshop. Learners should make horizontal and vertical sectional drawings of the three-panel door with raised panels as well as the framed ledged and braced batten door.
- (d) More detailed presentations on the different parts of doors should be done to prepare learners to answer theoretical questions on doors as well as the drawing thereof. Teachers should stress the difference between line diagrams and two- or three-dimensional drawings to learners.
- (e) It is recommended that scale models of the different types of staircases be used as teaching aids so that learners can see the views from different sides. This should improve learners' understanding of the different views regarding the different types of staircases and enable them to make drawings thereof

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 2020 examinations.

5.1.1 PERFORMANCE TRENDS (2018–2020)

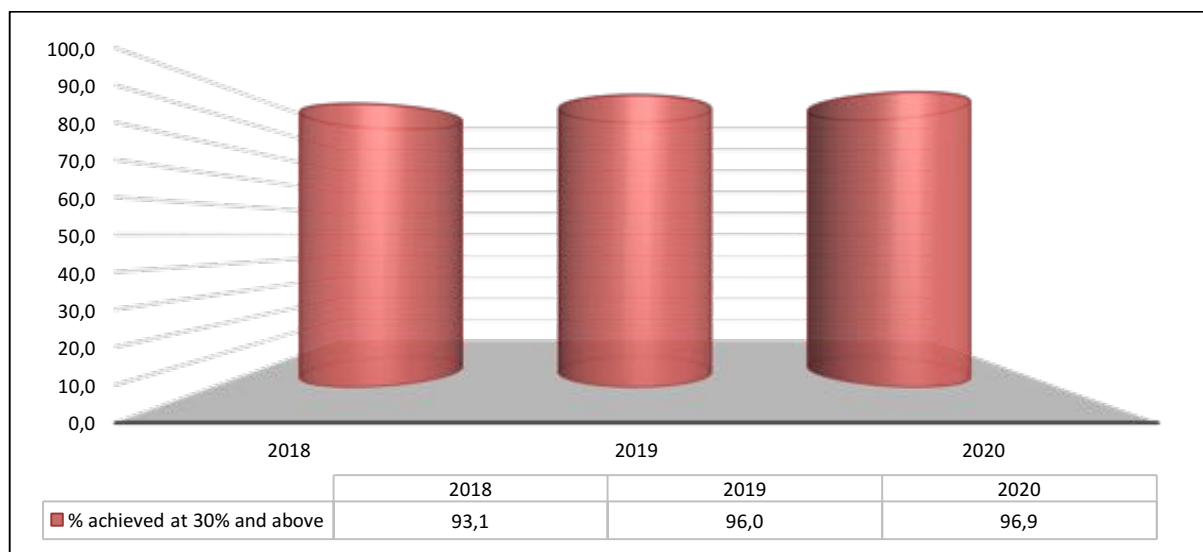
This was the third time that this subject was offered as an NSC examination subject. There was an increase of 99 candidates in this subject in 2020. The results reflect a marginal improvement in the pass rate at the 30% level to 96,9%. However, it was disappointing that 38,8% of candidates achieved over 50% this year in comparison to 41,5% of candidates doing so in 2019.

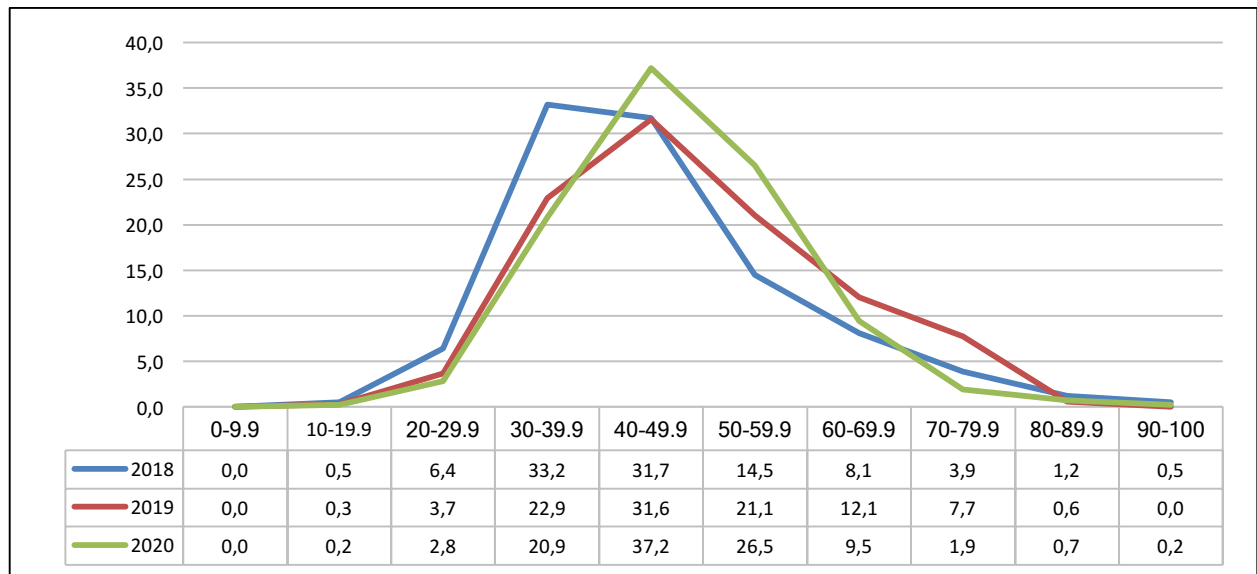
Table 5.1.1 Overall achievement rates in Digital Electronics

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

Further improved performance can be achieved if there is a strengthening of content knowledge in respect of switching circuits, digital and sequential devices and microcontrollers. In addition, learners should have practical exposure to these areas. They also need to be exposed to complex questions and problem-solving activities in all topics in the curriculum, from the earlier grades.

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



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

5.1.2 OVERVIEW OF LEARNER PERFORMANCE IN THE DIGITAL ELECTRONICS PAPER

General comments

- (a) An overall poor performance was recorded, even questions that were set at the lower cognitive levels.
- (b) Candidates could not interpret the requirements of the questions due to their poor language and comprehension skills.
- (c) It was evident that many candidates lacked relevant content knowledge and the necessary skills to answer the questions.
- (d) Many candidates experienced difficulty in answering questions of a narrative nature.
- (e) The question that required learners to explain basic operations of circuits is still a challenge because of a lack of knowledge and insight on the relevant concepts.
- (f) The application of mathematics and the formulation of responses after analysing circuits, requires attention.
- (g) Questions on the application of theory and the analysis of circuits were poorly answered. The output waveforms were not well presented and there was a decline in the correlation between the input and output waveforms.

General suggestions for improvement

- (a) **Use of Past NSC Papers:** It must be noted that past question papers serve as one of many teaching and learning resources. These papers are expected to be used for revision purposes only as they cannot replace the CAPS document. Every learner must have access to past examination papers. Papers such as the 2018 exemplar, November 2018/19/20 and the May/June 2019/20 supplementary papers would be

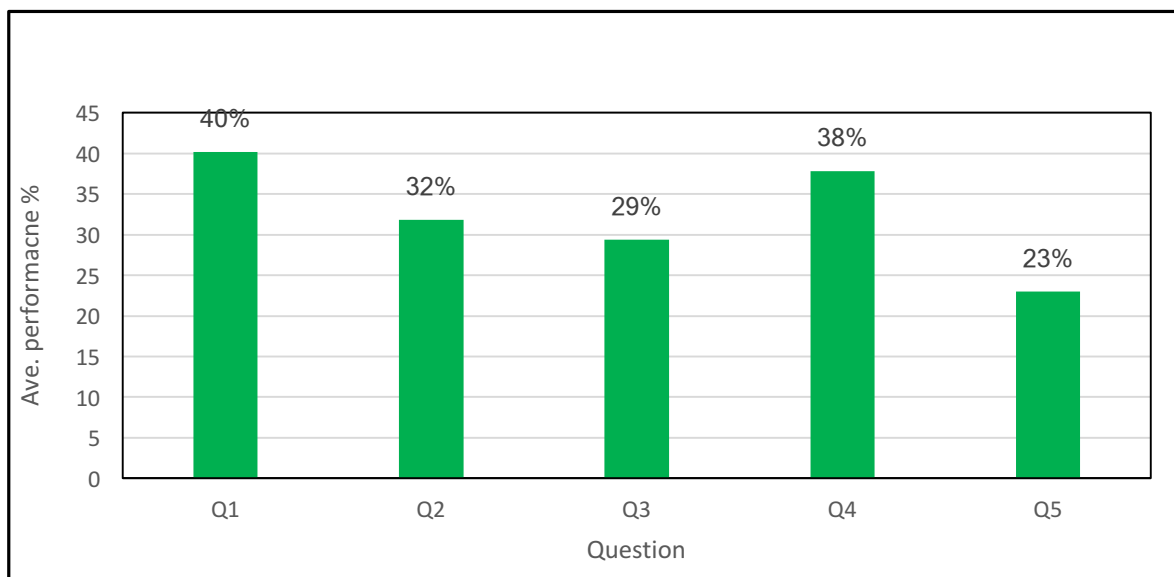
appropriate for revision purposes as these are based on the current CAPS content. In addition, teachers should ensure that learners revise questions on semiconductors, switching circuits, digital and sequential devices and microcontrollers, as these are stipulated for Grade 12 in the CAPS.

- (b) **Revision of Relevant Grades 10 and 11 Content:** Although the NSC examinations only assess Grade 12 content, prior knowledge from Grades 10 and 11 syllabi may be useful or necessary to answer some of the questions.
- (c) **Time Management:** Learners must be trained in the art of managing their time and to adhere to the suggested time allocations provided in the paper. The mark allocation and the spaces provided in the answer book are good indicators of the amount of information needed.
- (d) **Practical Experiments and Past Papers:** Teachers must conduct more practical experiments with learners, showing them the working principles and understanding applicable to Q2 to Q5. Learners should use past Grade 12 exam papers to develop the necessary interpretation skills required of the various questions.

5.1.3 DIAGNOSTIC QUESTION ANALYSIS OF DIGITAL ELECTRONICS

The following graph is based on data on a random sample of learners. 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 learners.

Graph 5.1.3 Average performance per question in the Digital Electronics paper



Q	Topic/s
1	Safety
2	Switching circuits
3	Semiconductor devices
4	Digital & Sequential devices
5	Microcontrollers

The average performance in Q2 to Q5 was very poor. Q5 covered microcontrollers and was the worst answered question, followed by Q3, which covered semiconductor devices. Candidates seem to lack basic content knowledge and therefore found it difficult to answer the questions set.

5.1.4 ANALYSIS OF LEARNER PERFORMANCE IN EACH QUESTION IN THE DIGITAL ELECTRONICS PAPER

QUESTION 1: OCCUPATIONAL HEALTH AND SAFETY

Common errors and misconceptions

- (a) In Q1.1 many candidates could not correctly define health and safety equipment. This question needed a two-part approach; a description of any article that is manufactured and a link to safety. Many candidates simply provided a vague explanation on safety. Some candidates defined 'Health and Safety equipment' separately, i.e. a definition for safety, and definition for Safety equipment.
- (b) A large number of candidates were not able to respond to human rights related to the workplace but offered other rights which were incorrect, in Q1.2.
- (c) In Q1.3 many candidates were not able to write the correct incident to be reported on, instead they commented only about the machines that were not working. Many candidates did not interpret this as a major incident and many used examples from an unsafe act or unsafe condition. The responses were generally vague and not to the point.
- (d) In Q1.4 the candidates provided generalized answers about human rights that were not aimed specifically towards answering the question.
- (e) A large number of candidates did not describe how the master switch contributed to safety but they described the mechanics of the master switch. In Q1.5 many candidates did not mention that by cutting off the supply, this contributed to safety. Most of the candidates explained what a master switch is, instead of explaining its contribution to safety.

Suggestions for improvement

- (a) The teaching of Occupational Health and Safety should be done with reference to the OHS Act. The use of educational videos and excursions will improve learner understanding.
- (b) For effective teaching and learning, the emphasis should be related to OHS Act and teachers should create an industrial environment for learners to understand this question through videos. Bring the industrial environment close to the candidates or have an education excursion to achieve this aim.
- (c) It is clear that poor comprehension was a problem. Revision programmes must include exercises requiring explanation, definition and application of safety as well as practical application.
- (d) Subject advisors must identify educators who require content and didactic training, and design a programme for them.

- (e) Candidates must be encouraged to read the questions thoroughly and to understand the requirements of the different types of questions i.e. name, explain, discuss and define. Constant practice can enhance their ability to answer these questions as expected.

QUESTION 2: SWITCHING CIRCUITS

Common errors and misconceptions

- (a) In Q2.1 many candidates were unable to state the difference between the a-stable and bi-stable multi-vibrators with reference to their inputs; instead they only stated how they produce the output waveform or the function of the two circuits. In Q2.1.1 the majority of candidates did not know the function of capacitor C_1 . In Q2.1.2 the charging voltage of V_{C_1} was not exponential or it was inverted. Most candidates could not draw the output wave forms. In Q2.1.3 many candidates scored only one mark here because they correctly identified the LED that goes on but could not explain why it happens.
- (b) Most of the candidates struggled to write about the operation of an a-stable op-amp multi-vibrator correctly or logically. The majority of candidates did not know the operation of this circuit and lost 6 marks in the process. Responses were generally vague. Many did not attempt Question 2.
- In Q2.2.1 most candidates could not identify the circuit.
 - In Q2.2.2 candidates explained the connection of the circuits instead of describing the operation of the identified circuit. These candidates struggled to describe the working principle of the circuit.
 - In Q2.2.3 candidates' responses were vague and they could not identify the specific resistor that should be decreased. Many candidates stated that the resistors must be increased.
- (c) In Q2.4 the candidates failed to answer the sub-questions as the majority could not understand the operation of a 555 timer.
- In Q2.4.1 most candidates struggled to notice that the circuit had a feedback loop. They described it as an open-loop circuit and also provided incorrect motivation. It was clear that they were guessing because their explanations did not correlate with their answers. Some candidates answered this sub-question correctly, but could not provide valid motivations for their responses.
 - In Q2.4.3 the inappropriate responses clearly show that candidates have insufficient knowledge of these concepts.
- (d) In Q2.5.1 some candidates could not provide the function of C_1 .
- Candidates experienced problems with the correct formula to calculate the output voltage in Q2.5.2. Most stated it as $V_{out} = V_1 + V_2$. Many were unable to identify the correct formula and they also struggled with the manipulation of the formula.
 - In Q2.5.4 a few candidates showed an understanding of what will happen when S_1 is open. Most candidates incorrectly stated that the output voltage is zero.

- (e) Most candidates identified the circuit as a comparator in Q2.6.1 but they did not know that there are two types, namely *inverting* and *non-inverting* comparators. The majority of candidates wrote inverting op-amp which was the incorrect answer. A few candidates did not recognise the inverting comparator.
- (f) In Q2.7 candidates failed to respond appropriately to the operation of a passive RC differentiator. They also could not describe the working principle of the circuit.
- (g) In Q2.8 many candidates failed to explain why the op-amp integrator can produce a steadily falling output voltage when the square wave is applied to the input. They could not even draw the output waveforms for different time constants and they also had problems in describing the working principle of the circuit.
 - The majority of candidates did not attempt Q2.8.1.
 - In Q2.8.2 some candidates drew the incorrect waveform and others had the incorrect orientation of the waveform.

Suggestions for improvement

- (a) The content gaps, coupled with the apparent lack of training of teachers, contributed to poor learner performance. It is vital to provide formal training to teachers on this topic.
- (b) If the teaching time (contact time) like periods for THEORY and PRACTICALS can be more efficiently used by candidates and teachers with less disruptions, then learner performance will improve.
- (c) Past examination papers can assist learners to focus on the different styles of questioning and variations of responses.
- (d) In order for learners to attain mastery in this section, the theory must be supported by simulations. This will give the candidates a greater insight to the understanding and the workings of the circuit.
- (e) All classical circuits should be summarised and possible variations of each circuit must be worked out, giving the learner more insight and confidence in this section.
- (f) Each switching circuit should be explained and analysed separately, and questions from previous papers must be used to assess candidates. Grade 10 and 11 theoretical knowledge must be recapped and revised. This will ensure that candidates will be able to explain how a capacitor charges, and the purpose of R_1 and R_2 used as a voltage divider circuit.
- (g) Teachers must ensure that calculations include the correct steps according to the national marking memorandum so that learners do not lose marks unnecessarily.
- (h) Many candidates were not able to distinguish between the theory and the calculations, and the fact that many candidates were not in school, they could not receive hands-on experience with simulations. Some schools used ZOOM meetings but this is not effective for simulations. Specific videos must be made on simulations so learners can familiarise themselves with them and strengthen their theoretical knowledge in the process.

- (i) Teachers are advised to give learners more assessment activities (either informal or formal tasks) on the content of this question.
- (j) Short class exercises are recommended for calculations requiring learners to manipulate the formula to arrive at the correct answer.
- (k) Questions from previous examination papers can be used for classwork. This will assist in preparing learners adequately for the final examination.
- (l) Teachers should identify areas of their own weaknesses by answering past question papers. Based on their performance, they could strive to address their gaps and find easier ways to impart this information to learners in an effort to improve their results.

QUESTION 3: SEMICONDUCTOR DEVICES

Common errors and misconceptions

- (a) In Q3.1.1 candidates confused op-amp characteristics with resonance theory. Most candidates did not know the characteristics of an ideal op-amp.
- (b) In Q3.1.2 the concept of dual power supplies used to amplify an AC signal was not understood by many candidates. Many could not associate a sine wave with one rail of a dual supply supplying the positive half cycle and another supplying the negative half cycle with a zero-volt reference. Candidates could not explain how an ideal op-amp amplifies alternating voltages. They just wrote, 'it needs two voltages'.
- (c) In Q3.2.1 the concept of the virtual earth was not known by the majority of candidates. Most candidates could not explain why 'X' was referred to as a virtual point. Most failed to explain this because their responses showed that they did not know the operation of the ideal op-amp and inverting Op- amp amplifier.
- (d) In Q3.2.2 some candidates used the incorrect formula, incorrect substitution and engineering notation. This contributed to the low marks in this section. Most candidates could not understand the difference between the non-inverting and inverting amplifiers, because a majority of them used the non-inverting amplifier, which is incorrect. They could not manipulate the formula to get R_F nor could they use their calculator properly to calculate R_F .
- (e) In Q3.3.4 the function of the two comparators was not known by many. Vague and incorrect answers were given here. Most candidates did not know the function of a Comparator or Flip flop, when used in a circuit. Many struggled to distinguish between the function of the components and the operation of the components asked. Most of the candidates' answers were based on function and not operation, and that resulted in very low marks for this question.
- (f) In Q3.3.5 candidates struggled to distinguish between the function of the components and the operation of the components asked. Most of the candidate's answers were based on function and not operation and that resulted in very low marks for this question.

Suggestions for improvement

- (a) Teachers should place additional focus on the following issues when revising this section of content with candidates:
- Analysis of different circuits
 - Reading information from the data sheet
 - Explanation, drawing and construction of prescribed components
 - Explanation of circuits and their operation
 - Exposure to different components
 - Use of datasheets
 - Exposure to simulations
 - Areas of calculations must include the correct steps according to the National marking guideline so that marks are not lost unnecessarily.
- (b) Study and analyse the internal circuit diagram of a 555 IC, and the relationship between the three 5 k Ω resistors and how the supply voltage is proportionally shared by the two comparators. Give learners more exercises on the content of this question.

QUESTION 4: DIGITAL AND SEQUENTIAL DEVICES**Common errors and misconceptions**

- (a) In Q4.2 candidates could not identify the figure as it was not the same as the one in a textbook. This is, however, based on common knowledge and a few candidates did get it right.
- (b) Candidates either did not attempt Q4.3 or they guessed an incorrect answer. The two classes of flip-flops were not known. The question confused candidates as they thought that it expected them to name the types of RS latches. Candidates could define the concept of the content that was asked, but struggled to explain its relationship to the question being asked.
- (c) In Q4.4 many candidates were unable to complete a drawing of the 4-bit parallel adder. Labels were omitted, as well as the C_o and C_{in} connectors.
- (d) Most candidates could not complete the table in Q4.5 correctly. Some candidates provided random incorrect responses. This clearly indicates that candidates do not understand how the 2-bit binary to decimal decoder operates.
- (e) In Q4.7 candidates were either confused or they did not understand what was required because many thought that the question asked about asynchronous and synchronous circuits instead of combinational and sequential circuits. Candidates know the concept of the content that was being asked, but struggled to explain the content in relationship to the question being asked.
- (f) In Q4.9 the explanation for the term *counter* was poorly answered by all candidates. Candidates knew the concept of the content that was being asked, but they struggled to explain the content in relationship to the question being asked.
- (g) The explanation for the term propagation delay was poorly answered in Q4.10 by all candidates.

- (h) In Q4.11 most candidates could not draw the output waveforms of the circuit nor could they explain the purpose of the AND gate. Most candidates could not give the purpose of the AND gate in Q4.11.2.
- (i) Candidates struggled to identify the type of register in Q4.12.1.
- (j) In Q4.12.3 candidates struggled to describe the operation of a register.

Suggestions for improvement

- (a) Learners need more exposure to the simulations that can be used, to enhance learning and conceptual understanding of the curriculum. This part of an examination paper requires higher-order thinking and understanding.
- (b) Drawings done by candidates should be of the same standard as done on the diagram sheet from the DBE and must always be labelled. All inputs must correlate to the outputs.
- (c) The teaching approach should be:
 - theory first;
 - drawing mastery of circuits including correct labels;
 - then characteristics;
 - the effect of changing parameters; and
 - fault conditions and its effects.
- (d) Understanding of the:
 - Half adder/full adder and its truth table
 - Flip flops, truth table and the timing diagram including their triggering
 - Counter, their stages, course of delay in the output, and timing diagram
- (e) Teachers must take time to explain the difference between function, application and operation in regard to the different circuits being taught.

QUESTION 5: MICROCONTROLLERS

Common errors and misconceptions

- (a) In Q5.1 most candidates stated applications that are not used in commercial devices.
- (b) Candidates' descriptions of the CPU in Q5.2.2 were too general and marks were lost. Most candidates could not explain the function of the CPU properly.
- (c) In Q5.2.3 candidates' descriptions were too general for the I/O unit. Most candidates could not explain the function of the I/O unit properly.
- (d) Many candidates only provided a maximum of two advantages of the microcontrollers over discrete components in Q5.3.
- (e) In Q5.6 the majority of candidates could not answer this question. In Q5.6.2 most of the candidates could not explain the function of the control bus. They simply stated that it controls the instruction instead of saying it issues a control instruction. In Q5.6.3 most candidates could not explain the function of address bus. They stated that it addresses the information instead of saying it locates and transmits the control instruction.

- (f) In Q5.7.1/2/3 the characteristics/function/applications of the SPI was poorly answered by all candidates. Most candidates could not state characteristics, function and two applications of SPI.
- (g) Candidates could not state the typical voltages for the RS-485 interface in Q5.8.1. Most candidates just stated that logic 1 more/+5 V and logic 0 is less/-5 V.
- (h) In Q5.8.2 devices that use the RS-485 were not known. Candidates could not list devices that can be used with the RS – 485 interface.
- (i) Candidates confused the label B with the transmission line instead of the direction of data flow in Q5.9.1.
- (j) In Q5.9.2 the majority of candidates could not describe how data is transferred through the device. The majority of candidates could not describe how data is transferred from the sender to the receiver. Candidates failed to explain the flow of data COMMUNICATION of SYNCHRONOUS COMM as they were not logical and again not using correct terminology
- (k) There was an improvement in Q5.10. The common errors were symbols and labels being omitted. Few candidates did not complete the flow-chart well but majority got full marks. Quite a few candidates did not know pickaxe programming, and they showed that they do not use programming protocols and algorithms correctly to complete the flow-chart.

Suggestions for improvement

- (a) Learners need more exposure to the simulations that can be used, to enhance learning and conceptual understanding of the curriculum. This part of the exam required higher order thinking and understanding. In this question candidates failed to give a good response. It is clear that the majority of schools do not have microcontrollers, candidates did not work on them therefore the knowledge, and responses are vague. There is however, an improvement in the responses of flow diagrams when compared to last year.
- (b) Teachers must give learners more exercises on the content of this question.
- (c) Use previous years' exam papers for exercises in class to prepare the learners for the possible questions they can receive in the coming examination.
- (d) Teachers must explain to the learners, the difference between function, application and operation in regards to the different circuits being taught.

5.2 ELECTRONICS

The following report should be read in conjunction with the Electronics question paper of the November 2020 examinations.

5.2.1 PERFORMANCE TRENDS (2018–2020)

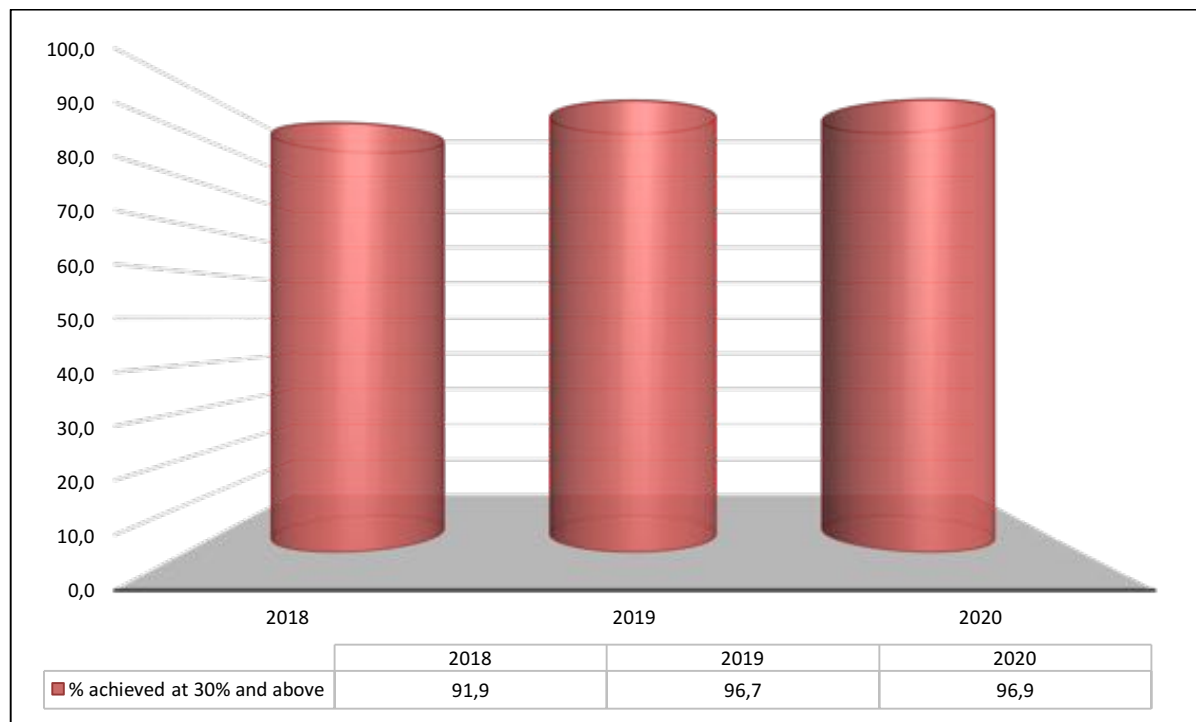
This was the third time that this subject was offered as an NSC examination subject. In 2019, 968 candidates sat for the Electronics examination i.e. an increase decline of 31 in comparison to the previous year. The results reflect that the pass rate at the 30% level were maintained at 96,9%.

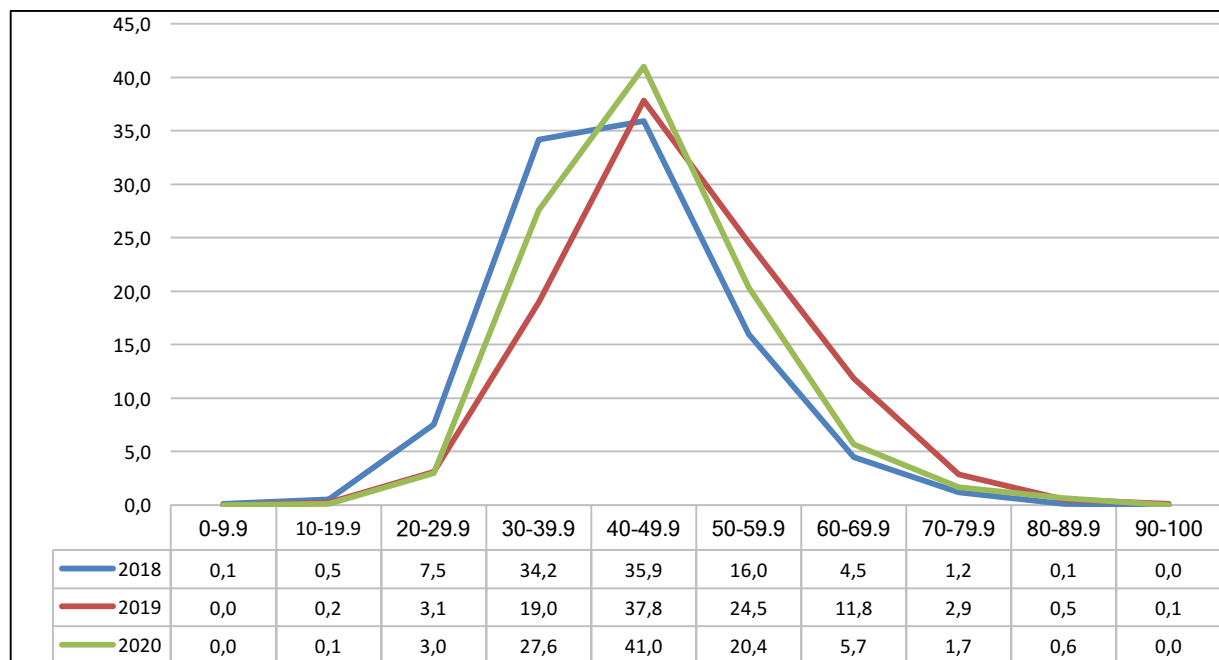
However, it was disappointing that only 28,8% of candidates achieved over 50% this year in comparison to 39,8% of candidates doing so in 2019.

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

Graph 5.2.1(a) Overall achievement rate in Electronics (percentage)



Graph 5.2.1(b) Performance distribution curves in Electronics (percentage)

5.2.2 OVERVIEW OF LEARNER PERFORMANCE IN THE ELECTRONICS PAPER

General comments

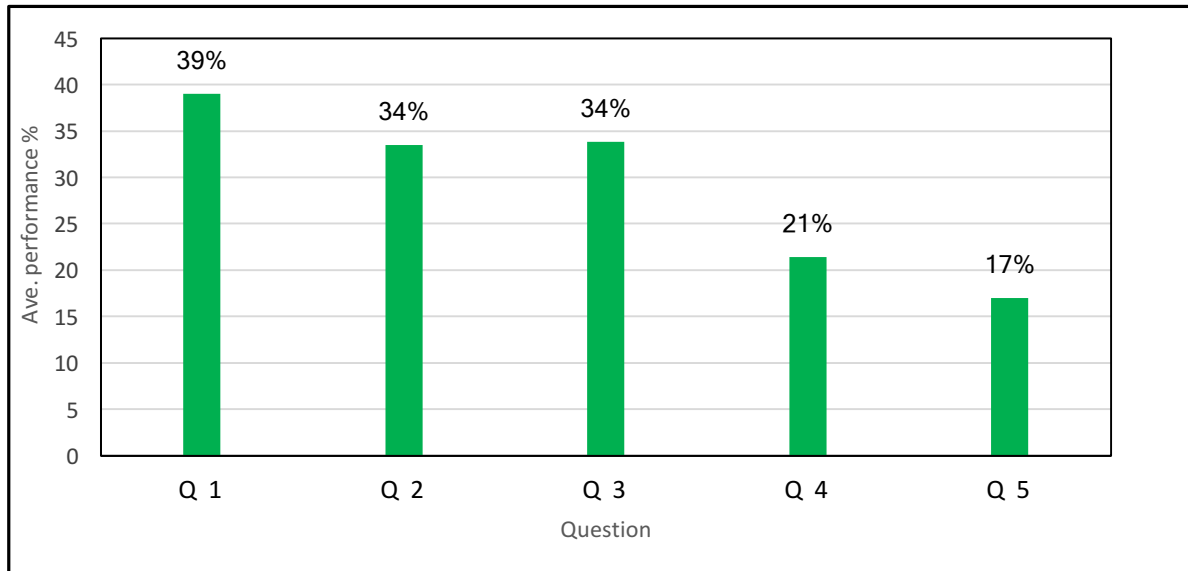
- (a) In general, the overall performance of candidates in the paper was very poor.
- (b) Q1 and Q2 were well answered but these questions comprised only 25% of the entire paper.
- (c) Q3, Q4 and Q5 were poorly answered. These questions comprised 75% of the total.
- (d) In general candidates made basic mistakes such as: not selecting correct formulae, not substituting correct values in formulae, omitting the correct units and using incorrect pre-fixes of values when doing substitutions.
- (e) Candidates had difficulty answering the narrative type questions.
- (f) Language use to answer questions was also very poor. Even though the level of language used in the question paper was simple and unambiguous, candidates' responses showed that they did not understand the requirements of questions.
- (g) It was evident that many candidates lack proper content knowledge and the necessary skills to answer the questions.
- (h) Judging from the answers presented, it was evident that candidates did not read the questions carefully and proceeded to give the wrong answers. Even the low cognitive questions were not being answered as expected.
- (i) Manipulation of formulae in calculations is still a challenge for many candidates. Both the application of mathematic principles and expression of responses require further attention.

- (j) Marks were lost for the omission of units in the calculations and/or for wrong substitution, and the omission of labels in the drawings.
- (k) The huge volume of circuit diagrams, output waveforms and characteristic curves is a challenge for most candidates.
- (l) 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, is a new concept and is a vast improvement over the past Electrical Technology approach. The EGD approach prepares candidates to think as engineers. Teachers, however, still need to apply this approach in their teaching.
- (m) Substitution of accurate values into the formulae is still a challenge. This contributed to candidates not calculating answers accurately.
- (n) Candidates could not draw output waveforms of the circuits.
- (o) Candidates did not know the function of components in circuits. It is of utmost importance for teachers to teach the function of components to learners. It forms part of circuit analysis and is crucial in understanding the operation of an electronic circuit.
- (p) 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.
- (q) Candidates could not use the answer sheets provided, correctly. To show the correlation between input and output waveforms accurately, the answer sheet is necessary. This step prepares candidates to think as engineers would, and teachers need to apply this approach in their teaching for all formal and informal activities.
- (r) There were numerous questions in the final question paper that were similar in nature to the exemplar and previous question papers. However, performance was very poor and it would seem that learners did not work through previous question papers in preparation for the final question paper.

5.2.3 DIAGNOSTIC QUESTION ANALYSIS OF ELECTRONICS

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

Graph 5.2.3 Average performance per question in the Electronics paper



Q	Topic/s
1	Occupational Health and Safety
2	RLC Circuits
3	Semiconductor devices
4	Switching Circuits
5	Amplifiers

It is evident from the graph above that there is an improvement in the performance in some questions. The responses of candidates in Q1 and Q2 were satisfactory. The responses to Q3 to Q5 is of great concern and needs urgent attention from both teachers and candidates.

5.2.4 ANALYSIS OF LEARNER PERFORMANCE IN EACH QUESTION IN THE ELECTRONICS PAPER

QUESTION 1: OCCUPATIONAL HEALTH AND SAFETY

Common errors and misconceptions

- (a) In Q1.1 many candidates could not correctly define health and safety equipment. This question needed a two-part approach; a description of any article that is manufactured and a link to safety. Many candidates simply provided a vague explanation of safety. Some candidates defined 'Health and Safety equipment' separately, i.e. a definition for safety, and a definition for safety equipment.

- (b) In Q1.2 a large number of candidates were not able to respond to human rights related to the workplace but offered other rights which were incorrect.
- (c) In Q1.3 many candidates were not able to write the correct incident to be reported on, instead they commented only about the machines that were not working. Many candidates did not interpret this as a major incident and many used examples from an unsafe act or unsafe condition. The responses were generally vague and not to the point.
- (d) In Q1.4 the candidates provided generalised answers about human rights that were not aimed specifically at answering the question.
- (e) A large number of candidates did not describe how the master switch contributed to safety but they described the mechanics of the master switch. In Q1.5 many candidates did not mention that by cutting off the supply, this contributed to safety. Most of the candidates explained what a master switch is, instead of explaining its contribution to safety.

Suggestions for improvement

- (a) The teaching of Occupational Health and Safety should be done with reference to the OHS Act. The use of educational videos and excursions will improve learner understanding.
- (b) For effective teaching and learning, the emphasis should be related to the OHS Act and teachers should create an industrial environment for learners to understand this question through videos. Bring the industrial environment close to the candidates or have an education excursion to achieve this aim.
- (c) It is clear that poor comprehension was a problem. Revision programmes must include exercises requiring explanation, definition and application of safety as well as practical application.
- (d) Subject advisors must identify educators who require content and didactic training, and design a programme for them.
- (e) Candidates must be encouraged to read the questions thoroughly and to understand the requirements of the different types of questions, i.e. name, explain, discuss and define. Constant practice can enhance their ability to answer these questions as expected.

QUESTION 2: RLC CIRCUITS

Common errors and misconceptions

- (a) In Q2.1.1 candidates could not draw the phasor diagram correctly and could not motivate why the circuit was capacitive. It seems that candidates are not that familiar with phasor diagrams. Many candidates did not attempt to answer the question. Those that did, neglected to label the drawing correctly. They also showed weaknesses in the meaning of lagging and presented incorrect responses. Candidates drew the sine waveforms with leading and lagging instead of the phasor diagram. In Q2.1.2 candidates did answer if the voltage is inductive/capacitive, but they could not explain the reason. Many did not explain their answer but simply stated that the circuit was RL.

- (b) Drawing and including the correct labelling for this phasor diagram was a problem for many candidates in Q2.2.4. Some did not include any labels. Many candidates did not know the difference between a phasor diagram and waveforms nor the direction of a phasor diagram.
- (c) In Q2.3 candidates could not identify what the phasor diagram in fig 2.3 represented. Candidates identified it as a current phasor diagram in Q2.3.1 and did not state whether it was series or parallel connected. They did not know that this phasor diagram was at resonance. Majority of candidates failed to identify the phasor diagram that was given in the question.
- (d) Candidates did not know why the voltage was used as reference in the phasor diagram in Q2.3.2. They also could not understand that voltage is used as a reference because it is a parallel circuit. The concept of the supply voltage being used as a reference was not known by many candidates.
- (e) A few candidates got Q2.3.3 wrong; they did not know the relationship between total current and impedance in a parallel resonant circuit. Candidates also did not know the characteristics of RLC parallel resonant circuits. Most of them stated that the impedance and the current will be the same.
- (f) In Q2.4.1 the formula from the formula sheet was transcribed incorrectly and the substitution was also incorrectly done, with the engineering notation not known. Poor calculator skills also contributed to candidates arriving at the incorrect answers.
- (g) Many candidates did not attempt to answer Q2.4.3. They either found it difficult to apply their knowledge of the characteristics of RLC at resonance or they simply did not know the characteristics.
- (h) In Q2.4.4 the manipulation of the formula to make C the subject of the formula was challenging for most candidates.
- (i) Candidates found it difficult to read the resonant frequency of the characteristic curve in Q2.5.2. Many candidates did not attempt to answer the question. Those that did, used the normal resonant frequency formula, which was not possible as L or C was not given. It seems that the candidates did not know the characteristic curve and what is represented on it. Most candidates used the formula:

$$f_r = \frac{f_1 - f_2}{2}$$

Instead of:

$$f_r = \frac{f_1 + f_2}{2}$$

And some could not even attempt the question. Many candidates found this question difficult because it seemed different from the classical RLC styled question, which they were more familiar with.

- (j) Many candidates did not attempt Q2.5.3. The few that did, used the incorrect formula and randomly calculated the angle instead of the bandwidth. The concept of the bandwidth was also not clearly understood by many.

Suggestions for improvement

- (a) All calculations need to have a correct formula, correct substitution, and the answer expressed with the applicable unit. More emphasis should be placed on phasor diagrams i.e. all labels, arrows and the angle must always be given.
- (b) Teachers should focus more on teaching the phasor diagrams, what they represent and how to draw them. They need to teach learners about the meaning of leading and lagging and should stress that the labelling of these diagrams are of utmost importance. If labelling is done incorrectly, no marks will be awarded.
- (c) Teachers must emphasise why a circuit is inductive or capacitive.
- (d) Encourage learners to label all sketches that they draw. If sketches are not labelled, no marks will be awarded as this is a clear instruction in question papers. Teach learners the difference between phasor diagrams and waveforms as many of them continue to draw the wrong type of sketch than what was asked in the question. The direction of rotation of phasor diagrams should be emphasised. Teachers should also illustrate when a circuit is leading or lagging and how to draw these phasor diagrams.
- (e) RLC phasor diagrams are always identified as a circuit connected in series or parallel. Stress this to learners to avoid answers such as voltage/current phasors. I_c and I_L is indicated as equal on this sketch and therefore learners need to indicate that this circuit is at resonance as well. It can only happen if learners know the characteristics of RLC circuits at resonance. Stress this to them and teach them how to apply this knowledge.
- (f) Teach learners the difference between series and parallel RLC circuits and which reference is used at each of these.
- (g) Characteristics of RLC circuits should be emphasised by teachers. Teach learners the conditions at resonates.
- (h) Teachers should allocate more time to teaching manipulations of formulas as this will assist learners with calculations. Teachers should also teach candidates how to convert micro, milli, kilo, mega, pico and nano values to normal values. They should not assume that learners know how this is done. Always explain to candidates how important it is to give the correct unit to an answer. Encourage learners to practise difficult calculations like these so that they will become more familiar on how to use their specific calculator correctly.
- (i) It seems that the candidates are unfamiliar with the characteristic curve of RLC-circuits. More time should be allocated to teaching this to learners. Practise these types of calculations with learners, so that they will become familiar with them.
- (j) More activities on the manipulation of formulae must be given to learners. The higher-order understanding of the application of circuits and concepts must be revised regularly and thoroughly. For calculation purposes, learners must be taught how to select the correct formula, manipulate them where necessary, apply the correct substitution, use the calculator correctly and include the correct unit for the answer.
- (k) Teachers should investigate the practical implication and application of RLC circuits which include the bandwidth, and incorporate this in lessons.

- (l) The following should be considered:
- The concepts of RLC circuit analysis from Grade 11, incorporating what learners learned in Grade 10;
 - Differentiation of phasor and vector diagram;
 - Proper planning and use of different resources as one resource proved not to be enough;
 - Work with nearby school teachers; and
 - Know your learners.
- (m) Teachers should focus more on the application of prefixes, the manipulation of formulae and practice calculator work with RLC calculations.
- (n) The definitions of the terms, explanation and descriptions of concepts that are likely to be asked in the exam need to be summarised in a booklet and handed to learners at the beginning of the year.
- (o) Learners must be trained to read the question carefully and to look at the marks that are allocated. The number of facts provided must correlate with the number of marks.
- (p) Candidates need to read questions with understanding so that they do not mix the answers. Similar questions should be given during the year in preparation for the final examination.

QUESTION 3: SEMICONDUCTOR DEVICES

Common errors and misconceptions

- (a) Candidates could not identify all the terminals of the MOSFET in Q3.1.1 and did not know the basic operating principles in Q3.1.2.
- (b) In Q3.2 candidates did not know the meaning of the negative resistance of a UJT.
- (c) Candidates were able to describe the construction of the transistor but did not explain the concept of its combination as asked in Q3.3.1.
- (d) In Q3.4.2 candidates could not explain why the op-amp is ideal to amplify alternating voltages.
- (e) Candidates could not answer Q3.5.1. They did not know the meaning of 'virtual ground'.
- (f) Many candidates selected the wrong formula to calculate the feedback resistor in Q3.5.2.
- (g) Candidates could not answer the majority of the sub-questions in Q3.6 because they lacked detailed knowledge of the internal operation of the 555 IC.

Suggestions for improvement

- (a) Teachers must spend more time in teaching the construction, operation and symbols of the different MOSFETs.
- (b) When teaching the operation of components, reference must be made to the characteristic curve and the construction of the components.
- (c) The operation of the Darlington pair must be carefully explained, as well as the advantages of this combination.
- (d) Teachers must provide a detailed explanation of the operation of Op-amp circuits and demonstrate it with practical circuits.
- (e) It is important to use practically built circuits with voltage measurements in conjunction with the theoretical concepts being addressed.
- (f) Teachers must emphasise the identification of formulae and link it with the correct circuits during class lessons. Teachers must also emphasise the importance of using the correct prefixes in all calculations and showing them in the substitution. This must be strictly applied 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.
- (g) 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 4: SWITCHING CIRCUITS**Common errors and misconceptions**

- (a) In Q4.1.1 candidates could not differentiate between multivibrators with reference to their inputs.
- (b) Many candidates could not describe the requirements of Q4.2.2. Their responses lacked technical detail.
- (c) Most candidates could not describe the operation of the identified multi-vibrator in Q4.4.2.
- (d) In Q4.3.1 candidates did not know the function of capacitor C_2 in FIGURE 4.3.
- (e) Conceptual knowledge was lacking in the attempt to draw the charging voltages of the capacitor in FIGURE 4.3
- (f) Candidates could not determine whether the circuit in Q4.4.1 was an open or closed-loop circuit.
- (g) In Q4.5.1 candidates did not know the function of capacitor C_1 in FIGURE 4.5.
- (h) The calculation of the output voltage of the summing amplifier in Q4.5.2 was a challenge to some candidates.

- (i) Very few candidates answered Q4.5.3 correctly and those that did, could not understand why the amplifier can amplify both positive and negative voltages.
- (j) In Q4.6.1 candidates could not identify the op-amp circuit in FIGURE 4.6.
- (k) Candidates were not able to draw the output wave in Q4.6.2.
- (l) In Q4.6.3 candidates had difficulty explaining why the op-amp circuit is driven into saturation.
- (m) Very few candidates could describe the operation of the RC differentiator in Q4.7. Their responses did not include all the required technical detail and they lost marks subsequently.
- (n) Candidates were unable to explain why the op-amp integrator in Q4.8.1 produces a steady falling output voltage when a square wave is applied. Their responses did not include the required technical detail.
- (o) Candidates could not draw the output waveforms in Q4.8.2 and Q4.8.3.

Suggestions for improvement

- (a) Teachers must indicate the differences between multi-vibrators with reference to inputs. They must consolidate theoretical knowledge with practical circuits.
- (b) Teachers must look for opportunities to demonstrate the practical operation of circuits to learners.
- (c) Illustrate the function of components practically to learners. Build the circuits and disconnect some components to show its effect on the output. Teachers can also use educational software for demonstration purposes.
- (d) Display charging and discharging voltages across capacitors on the oscilloscope can be demonstrated during practical lessons.
- (e) Teachers must dedicate more effort explain and demonstrate the difference between closed loop circuits and open loop circuits so that learners find them meaningful.
- (f) Show the function of capacitor C_1 practically to learners. Build the circuit and disconnect the capacitor to show its function. Display the input and output signals on an oscilloscope. Teachers can also use educational software for demonstration purposes.
- (g) Candidates must work through previous question papers to practise calculations and working with their calculators correctly.
- (h) Build op-amp circuits practically to demonstrate the importance of a split-supply in the operation of the circuit. Teachers can also use educational software for demonstration purposes.
- (i) Teachers must teach learners how to identify and analyse circuits.
- (j) Teachers must use similar input and output answer sheets to the ones available in the final exam for classwork exercises and informal tests throughout the year.

- (k) Teachers should change the values of components as well as the input signals when demonstrating circuits to the learners. Display the output waveforms on an oscilloscope during practical lessons to show what effect these changes have on the operation and output of the circuits.
- (l) Teachers must take care not to omit technical detail and chronological operation when explaining the operation of circuits.
- (m) Teachers must apply different waveforms to the inputs of op-amp circuits to demonstrate the effect of each specific signal on the output of that op-amp circuit. Teachers can also use educational software for demonstration purposes.
- (n) Learners should practise the drawing of input and output waveforms in classwork exercises and informal tests throughout the year. Teachers should change the values of components when demonstrating circuits to the learners. Display the output waveforms on an oscilloscope during practical lessons to show what effect these changes have on the operation and output of the circuits.
- (o) When explaining the operation of the different circuits, teachers also need to build the different circuits and demonstrate these to learners by displaying the different waveforms on the oscilloscope. Thereafter, learners must build these circuits practically, as prescribed by the CAPS policy document and not focus on the circuits and simulations in the prescribed PAT only.

QUESTION 5: AMPLIFIERS

Common errors and misconceptions

- (a) In Q5.1.1 the concept of feedback in amplifiers was not clearly understood.
- (b) Candidates could not explain distortion with reference to amplifiers in Q5.1.2.
- (c) Candidates could not identify the circuit in Q5.2.1 and confused the biasing method asked in Q5.2.2 with Class B.
- (d) Most candidates identified the correct formulae in Q5.2.3 and Q5.2.5 but could not substitute the values accurately. They also omitted the correct SI unit in their answers.
- (e) In Q5.2.5 candidates could not explain how an increase in V_{in} affects the output voltage of the given amplifier.
- (f) In Q5.3 candidates could not identify the given points in the characteristics curve of the common emitter amplifier.
- (g) Candidates confused the push-pull amplifier in Q5.4 with a transformer coupled amplifier. All sub-questions were vaguely answered where specific detail was required.
- (h) Candidates could not identify the circuit in Q5.5.1 as a RF amplifier, which led to poor responses to all sub-questions of this circuit. Candidates could not explain the energy transfer in the tank circuit in Q5.5.5.
- (i) Candidates could not correctly identify the circuit in FIGURE 5.6. In Q5.6.2 and Q5.6.3 candidates could not explain how to achieve oscillation and how to obtain feedback in the oscillator circuit.

- (j) Candidates were unable to explain the function of the inductor in the circuit for Q5.6.4.
- (k) The majority of candidates could not answer Q5.7. Those who attempted it, described the working parameters of the current and voltage in the circuit. Candidates failed to show how the FET will minimise the loading effect on the preceding stages and did not comment on the relatively low input impedance of the bipolar junction transistor.

Suggestions for improvement

- (a) Basic concepts in the operation of amplifiers must be clearly introduced and explained.
- (b) The definitions and basic concepts of amplifiers must be drilled until learners master them.
- (c) Teachers must teach the skill of circuit analysis in order for learners to correctly identify circuits.
- (d) Teachers must emphasise the correct and accurate substitution of values in calculations throughout formal and informal activities.
- (e) Teachers must 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 to show its effect on the output of the circuit.
- (f) Teachers must consult and work through old question papers to explain the different push-pull amplifiers. This specific circuit is from the Exemplar 2018 question paper.
- (g) Teachers must teach characteristic curves of amplifiers with the circuit analysis and function of different components as a whole and not separately.
- (h) Teachers can 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.
- (i) Teachers must 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 to explain and demonstrate its operation.
- (j) Teachers should demonstrate the function of the components by either disconnecting them or replacing them with other components to show the importance of such specific components.
- (k) Teachers must explain the use of FET and BJT transistors in oscillator circuits as well as its advantages.

5.3 POWER SYSTEMS

This report should be read in conjunction with the Power Systems question paper and Marking Guidelines of the November 2020 examinations.

5.3.1 PERFORMANCE TRENDS (2018–2020)

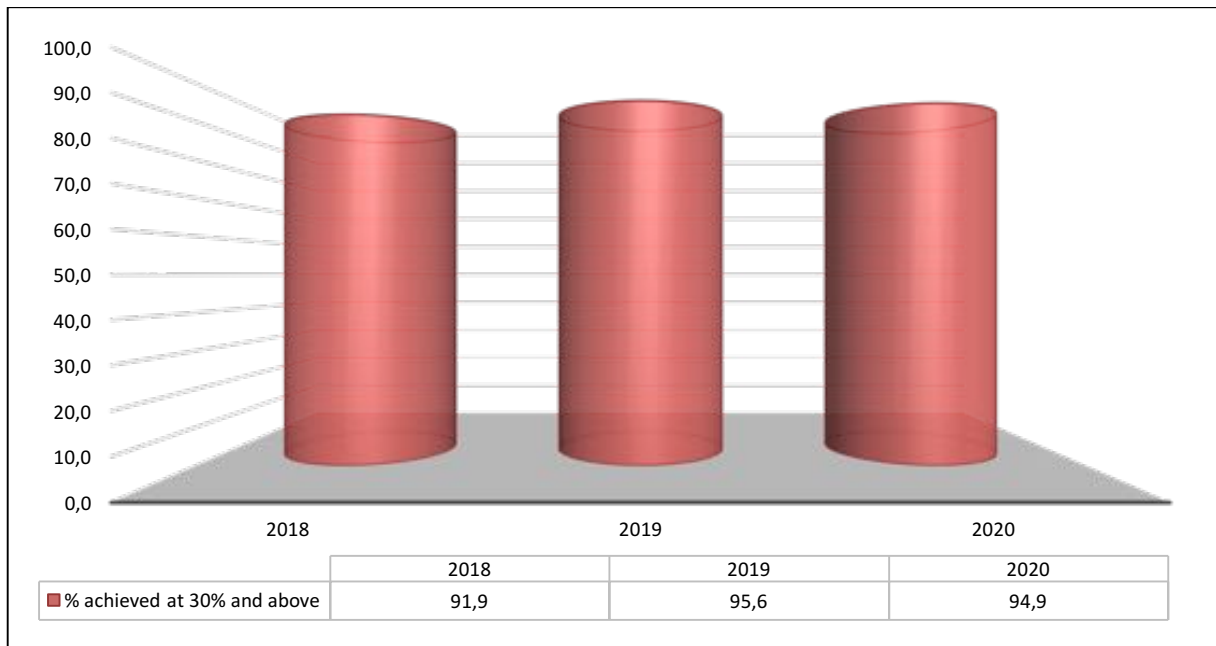
This was the third time that this subject was offered as an NSC examination subject. In 2020, 4 623 candidates sat for the Power Systems examination, i.e. a decline of 196 in comparison to the previous year. The results reflect a marginal decline in the pass rate at the 30% level to 94,9%. However, it was disappointing that 38,7% of candidates achieved over 50% this year in comparison to 43,6% of candidates doing so in 2018.

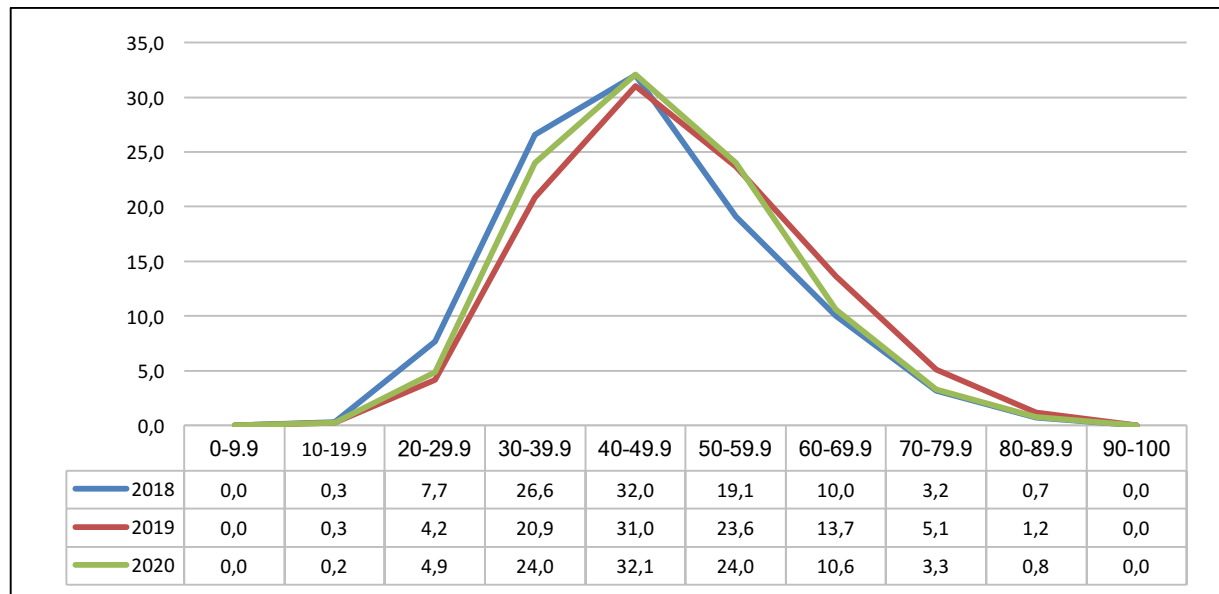
Table 5.3.1 Overall achievement rates in Power Systems

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

Despite stability in the curriculum and the fact that teachers and learners are becoming familiar with the assessment style of the subject, some challenges surrounding conceptual understanding and the interpretation of questions remain. Changing the subject of identified formula in calculations, identification of formulae from the given formula sheet and using the Engineering Graphics and Design (EGD) approach needs greater emphasis.

Graph 5.3.1(a) Overall achievement rates in Power Systems (percentage)



Graph 5.3.1(b) Performance distribution curves in Power Systems (percentage)

5.3.2 OVERVIEW OF LEARNER PERFORMANCE IN THE POWER SYSTEMS PAPER

General comments

- (a) Based on a sample of the candidates' responses, it is evident that most candidates:
- Are still experiencing challenges with interpreting the requirements of the question; and
 - Have difficulty in answering questions of a narrative nature.
- (b) Questions that require learners to explain basic operations of circuits are still a challenge because of a lack of content knowledge and insight of 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 from the formula sheet, manipulation of the formula, correct substitution, calculation and the writing of the correct unit is still a challenge.
- (e) Omission of labels in drawings has resulted in a loss of marks.

General suggestions for improvement

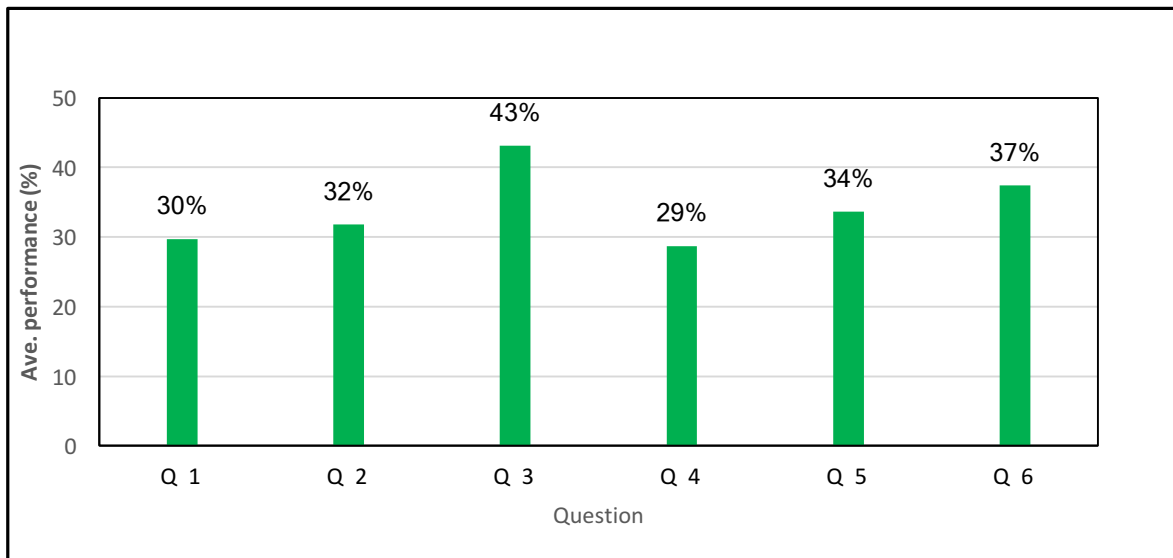
- (a) **Use of Past NSC Papers:** It must be noted that past question papers serve as one of many teaching and learning resources. These papers must be used for revision purposes only. Past papers cannot replace the CAPS document. Every learner must have access to past examination papers such as the 2018 exemplar, November 2018/19 and the June 2018/19 supplementary papers.

- (b) **Revision of Relevant Grades 10 and 11 Content:** In the Grade 12 NSC examinations, only Grade 12 content is assessed. However, prior knowledge from Grades 10–11 may be required to answer some of the questions.
- (c) **Time Management:** Learners must be trained to manage time allocated for each question, as specified on the question paper.
- (d) **Practical Experiments and Past Papers:** Teachers must carry out informal practical tasks with learners as this is required for better performance in Q2, Q4, Q5 and Q6.
- (e) Teachers need to penalise learners who do not write the correct unit or do not write a unit, during classwork and for assessment tasks, so that learners realise that they are going to lose marks if they commit those mistakes.

5.3.3 DIAGNOSTIC QUESTION ANALYSIS OF POWER SYSTEMS

The following graph is based on data of a random sample of learners. 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 learners.

Graph 5.3.3. Average performance per question in the Power Systems paper



Q	Topic/s
1	Occupational Health and Safety
2	RLC Circuits
3	Three-phase AC generation
4	Three-phase transformer
5	Three-phase motors and starters
6	Programmable logic controllers

5.3.4 ANALYSIS OF LEARNER PERFORMANCE IN EACH QUESTION IN THE POWER SYSTEMS PAPER

QUESTION 1: OCCUPATIONAL HEALTH AND SAFETY

Common errors and misconceptions

- (a) In Q1.1 many candidates could not correctly define health and safety equipment. This question needed a two-part approach; a description of any article that is manufactured and a link to safety. Many candidates simply provided a vague explanation on safety. Some candidates defined 'Health and Safety equipment' separately, i.e. a definition for safety, and definition for safety equipment.
- (b) In Q1.2 a large number of candidates were not able to respond to human rights related to the workplace but offered other rights which were incorrect.
- (c) In Q1.3 many candidates were not able to write the correct incident to be reported on, instead they commented only about the machines that were not working. Many candidates did not interpret this as a major incident and many used examples from an unsafe act or unsafe condition. The responses were generally vague and not to the point.
- (d) In Q1.4 the candidates provided generalised answers about human rights that were not aimed specifically towards answering the question.
- (e) A large number of candidates did not describe how the master switch contributed to safety but they described the mechanics of the master switch. In Q1.5 many candidates did not mention that by cutting off the supply, this contributed to safety. Most of the candidates explained what a master switch is, instead of explaining its contribution to safety.

Suggestions for improvement

- (a) The teaching of Occupational Health and Safety should be done with reference to the OHS Act. The use of educational videos and excursions will improve learner understanding.
- (b) For effective teaching and learning, the emphasis should be related to OHS Act and teachers should create an industrial environment for learners to understand this question through videos. Bring the industrial environment close to the candidates or have an education excursion to achieve this aim.
- (c) It is clear that poor comprehension was a problem. Revision programmes must include exercises requiring explanation, definition and application of safety as well as practical application.
- (d) Subject advisors must identify educators who require content and didactic training, and design a programme for them.
- (e) Candidates must be encouraged to read the questions thoroughly and to understand the requirements of the different types of questions i.e. name, explain, discuss and define. Constant practice can enhance their ability to answer these questions as expected.

QUESTION 2: RLC CIRCUITS**Common errors and misconceptions**

- (a) In Q2.1.1 candidates could not draw the phasor diagram correctly and could not motivate why the circuit was capacitive. It seems that candidates are not that familiar with phasor diagrams. Many candidates did not attempt to answer the question. Those that did, neglected to label the drawing correctly. They also showed weaknesses in the meaning of lagging and presented incorrect responses. Candidates drew the sine waveforms with leading and lagging instead of the phasor diagram. In Q2.1.2 candidates did answer if the voltage is inductive/capacitive, but they could not explain the reason. Many did not explain their answer but simply stated that the circuit was RL.
- (b) Drawing and inserting correct labelling of this phasor diagram was a problem for many candidates in Q2.2.4. Some did not include any labels. Many candidates did not know the difference between a phasor diagram and waveforms nor the direction of a phasor diagram.
- (c) In Q2.3 candidates could not identify what the phasor diagram in fig 2.3 represented. Candidates identified it as a current phasor diagram in Q2.3.1 and not whether it is series or parallel connected. They did not know that this phasor diagram was at resonance. Majority of candidates failed to identify the phasor diagram that was given in the question.
- (d) Candidates did not know why the voltage was used as reference in the phasor diagram in Q2.3.2. They also could not understand that voltage is used as a reference because it is a parallel circuit. The concept of the supply voltage being used as a reference was not known by many candidates.
- (e) Few candidates got Q2.3.3 wrong; they did not know the relationship between total current and impedance in a parallel resonant circuit. Candidates also did not know the characteristics of RLC parallel resonant circuits. Most of them stated that the impedance and the current will be the same.
- (f) In Q2.4.1 the formula from the formula sheet was transcribed incorrectly and the substitution was also incorrectly done, with the engineering notation not known. Poor calculator skills also contributed to candidates arriving at the incorrect answers.
- (g) Many candidates did not attempt to answer Q2.4.3. They either found it difficult to apply their knowledge of the characteristics of RLC at resonance or they simply did not know the characteristics.
- (h) In Q2.4.4 the manipulation of the formula to make C the subject of the formula was challenging to most candidates.
- (i) Candidates found it difficult to read the resonant frequency of the characteristic curve in Q2.5.2. Many candidates did not attempt to answer the question. Those that did, used the normal resonant frequency formula, which was not possible as L or C was not given. It seems that the candidates did not know the characteristic curve and what is represented on it. Most candidates used the formula:

$$f_r = \frac{f_1 - f_2}{2}$$

Instead of:

$$f_r = \frac{f_1 + f_2}{2}$$

And some could not even attempt the question. Many candidates found this question difficult because it seemed different from the classical RLC styled question, which they were more familiar with.

- (j) Many candidates did not attempt Q2.5.3. The few that did, made use of the incorrect formula and randomly calculated the angle instead of the bandwidth. The concept of the bandwidth was also not clearly understood by many.

Suggestions for improvement

- (a) All calculations need to have a correct formula, correct substitution, and the answer expressed with the applicable unit. More emphasis should be placed on phasor diagrams i.e. all labels, arrows and the angle must always be given.
- (b) Teachers should focus more attention on teaching the phasor diagrams, what they represent and how to draw them. They need to teach learners about the meaning of leading and lagging and should stress that the labelling of these diagrams are of utmost importance. If labelling is done incorrectly, no marks will be awarded.
- (c) Teachers must emphasize why a circuit is inductive or capacitive.
- (d) Encourage learners to label all sketches that they draw. If sketches are not labelled, no marks will be awarded as this is a clear instruction in question papers. Teach learners the difference between phasor diagrams and waveforms as many of them continue to draw the wrong type of sketch than what was asked in the question. The direction of rotation of phasor diagrams should be emphasized. Teachers should also illustrate when a circuit is leading or lagging and how to draw these phasor diagrams.
- (e) RLC phasor diagrams are always identified as a circuit connected in series or parallel. Stress this to learners to avoid answers such as voltage/current phasors. I_c and I_L is indicated as equal on this sketch and therefore learners need to indicate that this circuit is at resonance as well. It can only happen if learners know the characteristics of RLC circuits at resonance. Stress this to them and teach them how to apply this knowledge.
- (f) Teach learners the difference between series and parallel RLC circuits and which reference is used at each of these.
- (g) Characteristics of RLC circuits should be emphasized by teachers. Teach learners the conditions at resonates.
- (h) Teachers should allocate more time on teaching manipulations of formulas as this will assist learners in calculations. Teachers should also teach candidates how to convert micro, milli, kilo, mega, pico and nano values to normal values. They should not assume that learners know how this is done. Always explain to candidates how important it is to give the correct unit to an answer. Encourage learners to practise difficult calculations like these so that they will become more familiar on how to use their specific calculator correctly.
- (i) It seems that the candidates are unfamiliar with the characteristic curve of RLC – circuits. More time should be allocated on teaching this to learners. Practise these types of calculations with learners, so that they will become familiar with them.
- (j) More activities on the manipulation of formulae must be given to learners. The higher-order understanding of application of circuits and concepts must be revised regularly and thoroughly. For calculation purposes, learners must be taught how to select the

correct formula, manipulate them where necessary, apply the correct substitution, use the calculator correctly and include the correct unit for the answer.

- (k) Teachers should investigate the practical implication and application of RLC circuits which include the bandwidth, and incorporate this in lessons.
- (l) The following should be considered:
 - The concepts of RLC circuit analysis from Grade 11, incorporating what learners learned in Grade 10;
 - Differentiation of phasor and vector diagrams;
 - Proper planning and use of different resources as one resource proved not to be enough;
 - Work with nearby school teachers; and
 - Know your learners.
- (m) Teachers should focus more on application of prefixes, manipulation of formulae, and more practice in calculator work with RLC calculations.
- (n) The definitions of the terms, explanation and descriptions of concepts that are likely to be asked in the exam need to be summarized in a booklet and handed to learners at the beginning of the year.
- (o) Learners must be trained to read the question carefully and to look at the marks that are allocated. The number of facts provided must correlate with the number of marks.
- (p) Candidates need to read questions with understanding so that they do not mix the answers. Similar questions should be given during the year in preparation for the final examination.

QUESTION 3: THREE PHASE AC GENERATION (SPECIFIC)

Common errors and misconceptions

- (a) In Q3.1.1 most learners could not define reactive power. They gave the definition for apparent or active power. Some learners could not define the term efficiency. Learners confused the power factor definition with the reactive power.
- (b) In Q3.1.2 candidates confused 'product' instead of 'quotient' when trying to define efficiency by describing the formula verbally. The definition of efficiency was confused with the definition of the power factor.
- (c) Candidates did not understand the concept of power factor (effects and how to improve it) in Q3.3.
- (d) In Q3.4 most of the candidates answered that this is a wattmeter. They did not notice that it is power over a certain timeframe which is an energy meter or kilowatt-hour meter.
- (e) In Q 3.5.3 most candidates were not able to differentiate between power factor and phase angle in their calculations: If power factor = 0.8; then $\cos\theta = 0.8 \neq \cos(0.8)$. Most candidates were not able to understand that in delta configuration phase voltage

= line voltage. Candidates chose the correct formula but substituted incorrectly, thereby arriving at the incorrect answer.

- (f) Q3.6 – Candidates lost marks because they did not do the substitution correctly, e.g. 10 kW must be substituted by 10×10^3 or 10 000). Questions with prefixes in the units must be used with the prefixes in the substitution or be converted before being used in the calculations.

Example: $P_1 = 10 \text{ kW}$ and $P_2 = 3 \text{ kW}$ for calculation it must be written as follows:

$$\begin{aligned} P_T &= P_1 + P_2 \checkmark \\ &= 10 \text{ kW} + 3 \text{ kW} \checkmark \\ &= 13 \text{ kW} \checkmark \end{aligned}$$

OR

$$\begin{aligned} P_T &= P_1 + P_2 \checkmark \\ &= 10\,000 + 3000 \checkmark \\ &= 13\,000 \text{ W or } 13 \text{ kW} \checkmark \end{aligned}$$

NOT as follows:

$$\begin{aligned} P_T &= P_1 + P_2 \checkmark \\ &= 10 + 3 \times \checkmark \\ &= 13\,000 \text{ W or } 13 \text{ kW} \checkmark \end{aligned}$$

- (g) Candidates confused the power factor with the angle. When the power factor is given as 0.9, candidates use the $\cos 0.9$ in their calculation instead of just 0.9.

Suggestions for improvement

- Educators must emphasise the difference between star and delta connection and its related formulas. Emphasis on the active, apparent and reactive powers as well as appropriate formulas that go with them are very important.
- All concepts related to power factor must be clearly explained and revised. More emphasis should be placed on teaching learners the effects of power factor, the advantages of improved power factor for the supplier and the consumer and the possible disadvantages if this power factor weakens.
- Definitions should be stated in full. Finding the core parts of definition should be a regular exercise. Learners and teachers should engage in these activities together. Teach learners to then use all these core parts together to form full sentences for their answers. Answers should be structured in such a way that a fact is provided for each of the marks that are allocated for the question. All definitions should be given equal treatment, not just apparent power and true power.
- Teach learners techniques to improve the power factor and why we use these specific parts or components.
- Teachers should emphasise the difference between a wattmeter and a kilowatt-hour meter. Wattmeter is used to measure the power in a circuit and the kilowatt-hour meter to measure the energy used by a system or the kilowatts over a certain timeframe. Stress that when a timeframe is added to the question, it is energy consumed by a system.
- It is advisable to develop a chart as part of teaching aids, where the three powers, namely: 'active power', 'reactive power', 'apparent power' and the power factor will be explained or defined. These terms should be put on the wall so that learners become

familiar with them. This technique can also be used for other sections where similar misconceptions exist.

- (g) Reading the question with understanding is crucial in questions of this nature. Candidates will tend to provide inappropriate answers to questions only if they did not read the questions carefully. The skill of reading the questions with understanding can be honed throughout the year though constant practise. Learners should be taught to analyse the question before they attempt to answer it. In interpreting and understanding of questions, focus should be placed on the following verbs: 'explain' why, 'define' the term, 'describe' how and 'explain' operations.
- (h) Teachers should spend time in explaining the following concept:
- True power
 - Apparent power
 - Reactive power and efficiency
 - Power factor

NB. They can also use analogue to explain the concept of power factor

- (i) Calculations count for approximately 50% of the marks in the question paper. Learners should be trained on how to select the correct formula, manipulate this where necessary, and to substitute correctly, e.g. 2 kW should be written as 2 kW or 2 000 and not as 2).

$$\begin{array}{lll}
 P_T = P_1 + P_2 & P_T = P_1 + P_2 & P_T = P_1 + P_2 \\
 = 1,2\text{k} + 2,3\text{k} & \text{OR} & = 1,2 \times 10^3 + 2,3 \times 10^3 \\
 = 3,5 \text{ kW} & = 1200 + 2300 & \text{OR} \\
 & = 3,5 \text{ kW} & = 3,5 \text{ kW}
 \end{array}$$

The units must also be included at the end of the final answer. Learners should be exposed to more calculations and in the process, identify and address omissions (formulae, units, prefixes etc.), knowledge gaps and misconceptions.

Learners must also be encouraged to refer to the formula sheet because it gives the summaries of laws and principles.

- (j) Definitions, explanations and descriptions must be summarised for the learners in a booklet and given to them at the beginning of the year.
- (k) Learners must be taught the importance of the correct phase sequence adopted universally.
- (l) Calculations can only be learned with a lot of practice. Learners need to understand the data that is given and use the one they need to perform the calculation.
- (m) Calculations with prefixes in the units must be used with those prefixes in calculations or convert them to numbers before being used in calculation. Example: 5 kΩ must be written as 5 kΩ, 5×10^3 or 5000 in the substitution.
- (n) Teachers must ensure that learners always use the correct units in their calculations. The theory regarding the section is also important for learners to understand the section.

QUESTION 4: THREE-PHASE TRANSFORMER (SPECIFIC)**Common errors and misconceptions**

- (a) In Q 4.1 candidates provided the purpose of the transformer instead of the step-up transformer. Candidates confused voltage with current, stating that a step-up transformer steps up current. Candidates did not explain in full as they could not indicate that the purpose of a transformer is to step up the alternating voltage, they just stated that it steps up the voltage, and lost marks.
- (b) In Q 4.2 factors that can contribute to excessive heating of a transformer was not clearly understood.
- (c) Candidates could not understand the question on transformer cooling methods in Q4.3 as the transformer was already immersed in the oil i.e. oil is already used to cool-down the transformer, so the learner was expected to provide other alternative answers.
- (d) In Q4.4 candidates did not explain the consequences of transformer cooling failure but simply stated it, and lost valuable marks.
- (e) Candidates could not explain the link between secondary current and primary current in Q4.5. Basic conceptual understanding is lacking. Candidates correctly stated that an increase in the load will increase the current on the secondary side, which warranted 1 mark, but they could not elaborate on what will happen to the current on the primary side. The effect of increasing the load and the result on the primary current of the transformer was not expressed correctly by the candidates. Their response was incorrect and this shows a lack of understanding. Candidates could not analyse what would happen to the primary current when the load is increased.
- (f) Many candidates could not answer Q4.6, a relatively easy question. (Types of 3-phase transformer connections). Most candidates answered with only STAR or DELTA. They misread the part that says to form a single unit. Therefore, answers should have been STAR-STAR, DELTA-DELTA, STAR-DELTA or DELTA-STAR, because transformers consist of a primary and secondary side. The connections of the three phase transformer windings were not known by many candidates and therefore they did not give the primary and secondary connections but only one of them. Candidates mentioned the connection on one section of the transformer and not on both sections.
- (g) In Q4.7 candidates did not know the protective devices of three-phase transformers. Candidates did not know the electrical protective devices for a transformer.
- (h) The drawing of the core type transformer was poorly attempted in Q4.8. Many drew the symbol of a three-phase transformer and not the core part of the transformer. The sketches drawn were also not labelled, costing valuable marks.
- (i) In Q4.9 the safety measures followed by candidates are incorrect and dangerous in some cases. Responses like 'cut the voltage' 'use protective eye wear' and 'press that stop button' are not procedural responses. This impacts on safety and on the marks received in this question. Candidates confused safety working with transformers with safety working with PLCs.
- (j) In Q4.10 candidates lost marks on the calculation. Lack of transformer knowledge and understanding of three phase transformers is a concern which must be addressed as descriptive answers were required.

- (k) Q4.10.1 created some confusion because the information given allowed for alternative answers. Fortunately, the marking guideline made provision for these. Most candidates did not calculate the output power first, and used the apparent power as the output power. Candidates did not look at the mark allocation to notice that two calculations are needed. Some candidates provided answers with the incorrect units or without units. Candidates could not calculate the output power while some of them mixed the output and the input.
- (l) In Q4.10.2 most candidates used the formula $TR = N_p/N_s$ and windings was not given. They should have used the correct formula $TR = V_p/V_s$ because those are the values that were given. Some candidates who used the correct formula, used the line voltages instead of the phase voltages.
- (m) Candidates neglected to change the kVA to VA in Q4.10.3, and thereby only received the mark for quoting the formula.

Suggestions for improvement

- (a) The simulation on the three-phase transformer that is done in the PAT from time to time is a good activity to supplement the transformer theory. This chapter contains many concepts to be properly understood, so teachers must ensure that learners fully understand these concepts for them to be able to answer these descriptive questions.
- (b) Teachers should focus on insight information as the questions are not posed in a straight-forward manner. Use keywords such as why, how, describe and explain when teaching the theory part of this topic.
- (c) Teach learners to focus on the key aspects of the question as this question clearly states that it is a single unit. Learners should look at the mark allocation and respond accordingly. Teach learners that the transformer consists of two sides to form one unit and that they must indicate how both sides are connected, for example STAR (primary)-DELTA (secondary) etc.
- (d) Teach learners to look at the mark allocation and answer accordingly. If possible, show learners by using practical examples in class so that they can understand how the different transformer cores, shell and core types, looks on the inside. Take time to explain the construction clearly and in full. Learners should always be encouraged to label all drawings, as this is where marks are allocated. Teach learners the difference between the symbol of a transformer and the drawing of the core of a transformer.
- (e) Explain the different types of power in transformers to learners and how to calculate the different types of power. Teach learners to look at the mark allocation to see how many calculations are required. Learners should use the correct formula from the formula sheet together with the information that they received. If voltages are used to calculate the transformer ratio, stress that this is phase voltages and not line voltages.
- (f) The theory covered in Grade 11 and 12 on transformers are the same, therefore more work could be done in Grade 11 and then reinforced in Grade 12.
- (g) The concept 'magnetism' should be revised in Grade 11.
- (h) More examples must be practised on this section. This will make candidates more confident when answering the question. A practical application will help make this section less abstract.

- (i) Educators should use a tracking system for their syllabus coverage so that all sections are adequately covered and learners benefit from all information according to CAPS.
- (j) The operation must be simplified by the educator into easy points so that the learner becomes familiar with the order and basic content. A more complete explanation can follow after the basic building blocks of the operation has been mastered by the learner.
- (k) Learners must be exposed to more real-life practice and applications on three-phase transformers by using excursions (Eskom or municipality), multimedia resources, etc.
- (l) Learners should be trained to read the question as a whole before they attempt to answer the question. They should be drilled with questions that have extra information, at different times during a year.
- (m) Manipulation of formula is a skill that learners need to hone and master during the year. Practice regard to manipulation of formula and the use of a calculator is essential.

QUESTION 5: THREE-PHASE MOTORS AND STARTERS (SPECIFIC)

Common errors and misconceptions

- (a) In Q5.1 some candidates did not know what mechanical inspection of a motor entails even though this was done in one of the PAT simulations. Candidates still gave electrical inspection as answers.
- (b) In Q5.3.1 candidates could not identify this control circuit. (Manual sequence starter). They identified different types of motors and not motor starters.
- (c) Candidates could answer Q5.3.2 but could not always get the full marks as per the marking guideline. (The function of the stop button and MC1(NO1)). Candidates could not explain this latching concept. The mark allocation here suggested that the candidate should explain the whole process and not give brief answers as they have done.
- (d) In Q 5.3.3 candidates lacked the logical reasoning to give a simple description of the control circuit of the manual sequence starter, they also could not explain the function of MC1(N/O1) or to explain the operation of the circuit correctly - they start by saying 'when the start button is pressed without referring to a specific start button.
- (e) In Q 5.4.1 most candidates could not provide correct units for the answer. Candidates failed to write the unit of synchronous speed.
- (f) Candidates struggled to calculate rotor speed in Q5.4.2 because they could not manipulate the formula correctly, hence, used the wrong formula to calculate rotor speed.

Suggestions for improvement

- (a) Teachers must spend a little more time on the concept and calculations of slip % and slip speed, synchronous speed and rotor speed.
- (b) The circuit diagrams with all its components of all the main motor control starters must be dealt with in detail, theoretically as well as practically. Learners must be able to distinguish between the different control circuits as well as the basic starting sequence

of each circuit. All the motor control circuits must be built and discussed to enhance the understanding of these control circuits.

- (c) Teach learners the difference between motors and motor starters. More focus should be given to the sequence starter and star-delta starters which learners are not as familiar with as the normal direct-on-line starter and forward-reverse starters. Teach them that each starter has its own name and function.
- (d) Latching is a very important concept as it is used in the starters as well. Teachers should focus on insight information as the questions are not posed in a straight-forward way. Use keywords such as 'why', 'how', 'describe' and 'explain' when teaching the theory part of the subject. Teach candidates to explain and not simply answer 'hold in contacts'
- (e) More calculations on speed formulae need to be practised.
- (f) Teachers should explain to learners that phase values will never be greater than line values; they can, however, be equal.
- (g) Explain/describe:
 - How control circuit operated;
 - Function of each component in the circuit;
 - Analysis of the control circuit; and
 - Insert fault in the circuit and ask learners to explain the effect the fault will have on the operation of the circuit. This is usually a 3-mark question.
- (h) Teachers need to encourage learners to understand the formula in relation to theory.
- (i) The challenge in Q5.3 might be attributed to lack of practical work at school. Teachers must communicate the application of theory using digital media, e.g. the internet or videos.
- (j) The control circuits, as stipulated in the CAPS, must be drawn on a chart with components, function and the operation in sequential form.
- (k) Teachers must teach the operation of control circuits of the different starters and the function of each component in the starter.
- (l) It is important that learners are taught the theory behind the starters. If learners know the operation of each starter and the function of each component in the starters, they will be able to answer all the questions in Question 5.

QUESTION 6: PROGRAMMABLE LOGIC CONTROLLERS (PLCs) (SPECIFIC)

Common errors and misconceptions

- (a) In Q6.1.3 a few candidates knew what an opto-coupler is. Many candidates did not attempt to answer the question. Candidates were not familiar with this term.
- (b) In Q6.2 many candidates gave one correct answer, but failed to give THREE hardware components. They repeated the same answer in different ways.

- (c) Candidates did not consider that Q6.3 was based on safety of the module and responses like 'ensure the supply is off' is not considering the safety precautions and procedures when the module is operating. Candidates seem to have problems expressing their thoughts when responding to this question.
- (d) In Q6.5 very few candidates could give an application of the inductive proximity sensor. Candidates replied with applications of different types of sensors and not the one that was specifically asked in the question. Most candidates were naming the areas where the sensor is being used (e.g. Manufacturing, Electric Gates, etc.) instead of the actual application such as in counting metal objects. The application of the inductive proximity sensor was not known by many.
- (e) Many candidates did not attempt to answer Q6.6.2. Those candidates who did attempt it, described the normal working principle of an on delay timer. In this instance the waves were given and needed to be incorporated in the answer. Most candidates did not consider the 'Wave form' in their answers.
- (f) In Q6.7 candidates did not identify this as a latching circuit, hence they could not correctly answer this correctly. Most candidates replied that the circuit will not function or would not work properly. In this case it is about the latching concept, which the candidates could not explain.
- (g) In Q6.8.1 most candidates gave the purpose or meaning of the lamps (e.g. Red light for 'OFF/Stop' state and Green for 'On/Go' state) instead of providing the CONDITION of the two lamps before the circuit is energized i.e. 'Red lamp will be ON, Green lamp, OFF'.
- (h) Many candidates could not explain the function of the MC in full - Q6.8.2. Most candidates focused more on the protection of equipment and the operator instead of looking at the basic primary function, i.e. opening and closing the contacts.
- (i) In Q 6.8.3 most candidates just replaced the logic symbols on a hard-wired control circuit instead of drawing the equivalent logic circuit diagram with correct symbols and labels. The ladder diagram has improved over the past years. All candidates are now attempting it and many are using the correct symbols. Candidates are still confused whether the switches should be open or closed but the marking guideline catered for that. A pattern that is surfacing often is that candidates are drawing a mirror image of the program and this poses a problem because the program only works in a left to right sequence. A correct mirror image is incorrect resulting in a loss of many marks. This program would not operate the programming software for PLCs.
- (j) Very few candidates could explain the principle of operation of the VSD in Q6.9. Many just referred to a change in frequency to adjust the speed of the motor. This shows a lack in conceptual understanding. Many candidates did not attempt to answer the question. Those who did, explained the function of the VSD and not the principle of operation. Full operation of VSD was not given, but only three procedural steps (points) were provided. Many candidates did not understand the principle of operation and responded in a general fashion instead of specifically explaining the logical sequence of events at each section of the circuit.
- (k) In Q6.10 candidates did not know the different types of SYNCHRONOUS AC motors used with VSD's; they mostly referred to the 3-phase induction motor. Candidates generally answered using asynchronous motors, but the question clearly asked for synchronous motors. The types of synchronous motors were confused with normal

motors, 'induction motors' and 'squirrel-cage motors'. Many candidates did not attempt to answer this question.

- (l) Because of a lack of content knowledge, many candidates could not respond appropriately to this question. Many candidates did not attempt to answer the question. The few that attempted this question, found the description of what is happening at the modulation very challenging. The duration of the switching time at area A and area B was not focused on, and candidates described the pulse width modulation instead. In Q6.11.2 candidates had problems understanding how the width of the pulses effect the output voltages.
- (m) In Q6.12 candidates focused only on personal protection (PPE) rather than on both personal and equipment protection. Specific precautions were not considered and candidates only focused on safety equipment and VSD safety.
- (n) Candidates could not identify the component in Q6.13. It seems that they are not familiar with this sketch of the VSD. Candidates were not familiar with the diagram/sketch. They could not identify the components in a regenerative-braking motor control circuit. They could not identify the braking unit or resistor.
- (o) In Q6.14 many candidates explained regenerative breaking and not what will happen to the energy, as was requested by the question. Most candidates did not attempt to answer this question. Those who did, could not explain what happens to the energy of the load but simply answered that energy is generated, and scored one mark. They did not explain how this energy is generated or where it is going. Most candidates either misunderstood the question or simply did not know the answers. Instead of focusing on what would happen to the energy, they explained the process of converting mechanical energy into electrical energy instead of what would happen to that energy. Candidates could not explain what will happen to the energy generated by the motor in the figure when the load moves down.

Suggestions for improvement

- (a) The teacher must ensure that all ladder diagrams are drawn correctly with ALL the correct labels.
- (b) Variable speed drives need a lot more attention in terms of block diagram, basic purpose of blocks, applications, advantages, as well as regenerative braking.
- (c) Teach learners what an opto-coupler is. Definitions should be given in full.
- (d) Teachers should show the hardware components of the PLC practically to learners. Teach them all the hardware components and not only the CPU.
- (e) Teach learners what *applications* are. Teach them to look for the specific words; in this case it is the inductive proximity sensor.
- (f) Teachers should teach learners the difference between the ON delay and OFF delay timers. These timers should be taught and explained with timing diagrams so that the learners become familiar with these timing diagrams as well. This can also be taught by showing them with practical simulations. Teach them by using words like energize, hold-in contacts and also strive to teach them the correct terminology. A wide variety of examples of circuits that use the two types of timers should be given for practice so that learners become familiar with these concepts.

- (g) Extra time should be given on teaching the latching concept to learners. Teachers can show this practically to learners as well.
- (h) Teach learners the function of the different components.
- (i) Teachers should allocate more time on teaching VSDs. Especially to what is happening at each stage and how it is achieved.
- (j) Explain to learners what regenerative braking is, and how it works. Use new ways and sketches so that learners understand this concept in full. Explain how the energy is generated and where does this energy go to or how it is dissipated to the resistor.
- (k) Avoid using previous question papers to teach learners, but use it to assess them.
- (l) The teacher needs to revise the logic gate, truth table and symbols for each gate and program these gates using the PLC unit for better understanding:
 - NOT gate
 - AND and NAND gate
 - OR and NOR gate
- (m) Teachers need to explain and demonstrate to learners how the conversion of hard wiring to ladder logic diagram is done and show correct labelling of inputs and outputs, program the ladder logic diagram by using the PLC unit. Note that ladder logic diagrams are drawn from:
 - Left power rails with input instruction to write 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.
- (n) Teachers should assist learners to:
 - Identify the latching circuit, which is the start button connected in parallel with the normally open contact (N/O) of the coil.
 - Understand the purpose of latching.
 - Explain the different types of contact used for latching, which is normally open contact (N/O).
- (o) 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
- (p) With regard to Q6.14, teachers must inform learners of the purpose or function of the braking resistor B during the process 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 when they see and touch, while others learn more effectively through verbal or visual ways.

CHAPTER 6

MECHANICAL TECHNOLOGY

6.1 AUTOMOTIVE

The following report should be read in conjunction with the Automotive question paper of the December 2020 examinations.

6.1.1 PERFORMANCE TRENDS (2018–2020)

In 2020, 2 839 candidates sat for the Automotive examination. This was the third examination in which the specialisation subjects were examined. The candidates performed well, with 94,1% of the cohort passing at the 30% level and above.

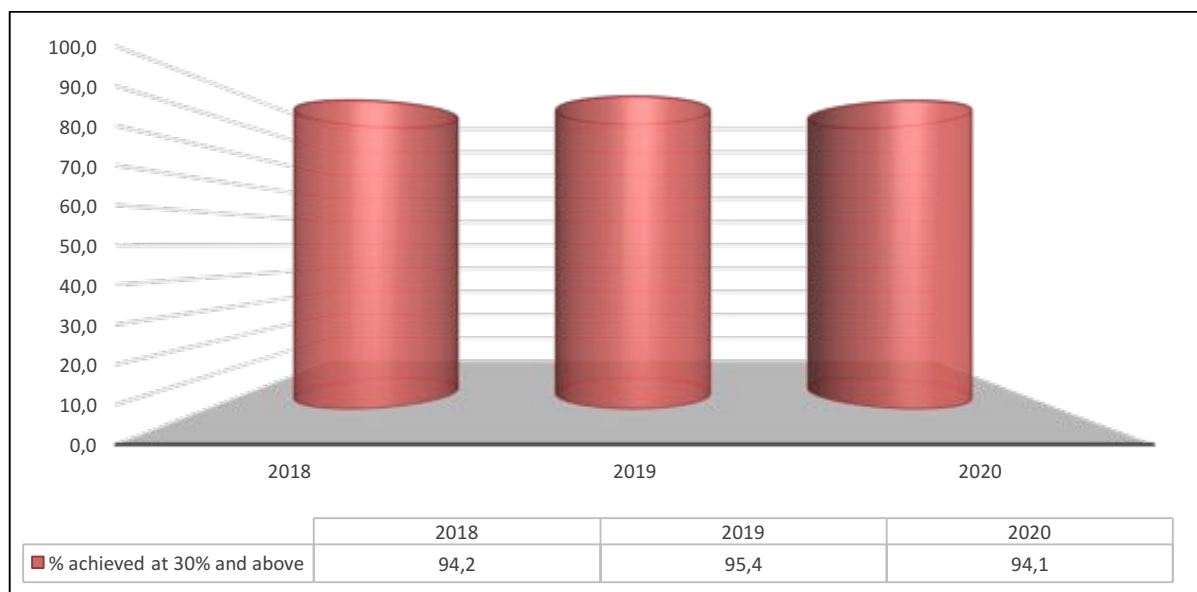
The results may improve in future, with stability in the curriculum and with teachers and learners becoming familiar with the assessment style of the subject. This is only the third time that Automotive specialisation subject has been written.

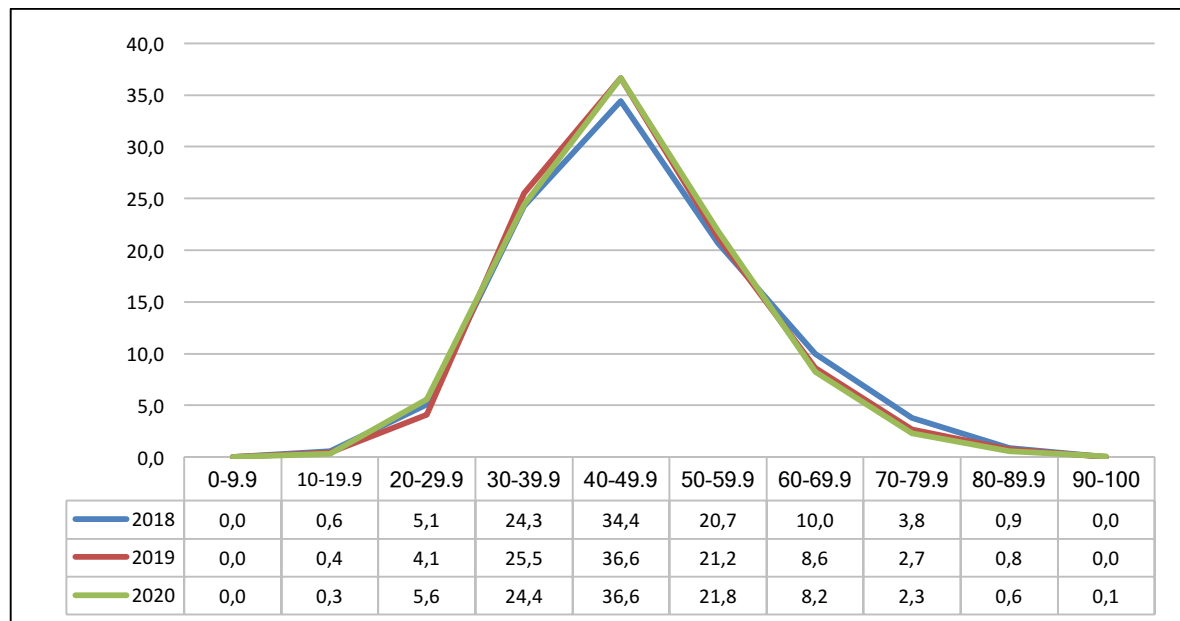
Table 6.1.1 Overall achievement rates in Automotive

Year	No. wrote	No. achieved at 30% and above	% achieved at 30% and above
2018	2 986	2 814	94,2
2019	2 784	3 657	95,4
2020	2 839	2 671	94,1

Candidates' performance in the 2020 examination was marginally lower when compared to 2019. Their problem-solving skills, mathematical skills and conceptual understanding still remain a challenge. In this regard, integrated problem-solving must become an integral part of teaching and learning.

Graph 6.1.1(a) Overall achievement rates in Automotive (percentage)



Graph 6.1.1(b) Performance distribution curves in Automotive (percentage)

6.1.2 OVERVIEW OF LEARNER PERFORMANCE IN THE AUTOMOTIVE PAPER

General comments

- The majority of the questions pertaining to pure recall of content were very poorly answered. 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*.
- Candidates did not manipulate formulae correctly. Teachers must emphasise the following: use of the relevant formulae provided on the formula sheet, correct substitution therein and providing the answer with the correct unit and direction, in terms of what is required by the question.
- The application of mathematical principles is still a challenge for candidates. A variety of questions from easy to difficult, in problem-solving activities that involve mathematical knowledge pertaining to the manipulation of formulae and the application of trigonometry, should be used as classwork, homework, tests and examinations.
- Candidates' handwriting should not be too small and calculations should not be cramped onto one section of the page. Candidates should ensure that their work is legible and neatly presented and they should also be able to follow the instructions on the cover.
- Learners need to be taught language skills in order to distinguish among terms such as 'before', 'during', 'while' and 'after' relating to safety applications.
- It appears that candidates do not read questions carefully and consequently do not answer certain sub questions appropriately.

- (g) A lack of knowledge of, or exposure to the use of various tools and equipment, was revealed by candidates.
- (h) Teachers should use previous NSC examination papers as support material and as exercises in the classroom, especially when training learners to answer multiple-choice questions.
- (i) Teachers are advised to use resources, such as video clips, charts, PowerPoint presentations and additional textbooks to illustrate the relationship between content and real-life situations.
- (j) If time constraints are experienced due to disruptions (like the Covid-19 pandemic), practical and theory tasks cannot be integrated in teaching and learning.
- (k) Integration of content from other subjects, such as Mathematics, Technical Mathematics, Physical Sciences, Technical Sciences and Engineering Graphics and Design will benefit learners.
- (l) Teachers and subject advisors should develop an item bank of questions and answers. Such questions should assess factual content, calculations and drawings.
- (m) To ensure that the curriculum is covered timeously, supervision and moderation by SMTs and/or PEDs is essential.
- (n) Teacher training needs to focus on the setting of examination papers according to cognitive levels (tests and examination). Sufficient resources are available for this purpose.
- (o) Teacher training should focus on content knowledge in addition to practical training.
- (p) Funding should be made available by the PED, to all schools offering practical assessment tasks which is strictly meant for the purchase of consumable materials.
- (q) Schools need to adhere to the notional time when setting timetables. Double periods should be allocated for practical tasks.
- (r) Schools and the PED need to support teachers with resources. It became clear in the responses from the learners that they have no idea of what some of the tools and equipment look like because they are not available in the workshops at school.
- (s) The candidates of 2020 were most disadvantaged due to lack of contact between teacher and learners. The candidates' responses to most questions was a clear indication that little or no teaching had taken place. This may have been due to many teachers being on comorbidity leave, Covid-19 positive or deceased, with no replacement teacher in place, as well as the period of the lockdown.
- (t) Most candidates did not have the opportunity to participate in on-line classes because of poor internet connectivity or non-availability of resources (including data).
- (u) Candidates found it difficult to do self-study because of all the technological terminology and practical applications.

6.1.3 ANALYSIS OF LEARNER PERFORMANCE IN EACH QUESTION IN AUTOMOTIVE

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Common errors and misconceptions

- (a) In Q1.4 most of the candidates could not identify the correct properties of materials.
- (b) The majority of candidates did not know the purpose of the *tempering of steel* in Q1.5.

Suggestions for improvement

- (a) Teachers should provide worksheets to identify the different properties of materials and then practically demonstrate these properties in the workshop.
- (b) Ensure in-depth revision and remedial measures 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 apply their practical knowledge in theory questions. Learners should be taught 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.
- (c) Teachers must use practical demonstrations to explain the definitions for the properties of steel.

QUESTION 2: SAFETY

Common errors and misconceptions

- (a) Q2.2 specifically asked for safety precautions that must be observed *after* the horizontal band saw has been switched on but instead candidates provided general safety precautions which included precautions that must be observed before and during the operation of a machine.
- (b) In Q2.3 some candidates did not know that by using surgical gloves, a person can prevent infection and protect the wound against contamination.
- (c) Some candidates did not read question Q2.5 carefully regarding the responsibilities of the employer for safety and health.
- (d) In Q2.6 majority of the candidates incorrectly stated the person responsible to administer first aid.

Suggestions for improvement

- (a) Learners need to read the question with understanding, as some learners tend to write down what comes to mind regarding the topic but not specifically what is required by the question.
- (b) Learners should be exposed to workshop practice relating to the safety of tools, the equipment in the workshop and the workshop environment.

- (c) When using tools and equipment, demonstrate the importance of using surgical gloves when someone cuts themselves. Video presentations and demonstrations would give learners an advantage when answering these types of questions on first aid. Also state who is responsible to administer first aid.
- (d) Teachers should provide worksheets to differentiate between the responsibilities of the employer and the employee with regard to safety in the workshop.

QUESTION 3: MATERIALS

Common errors and misconceptions

- (a) In Q3.1.1 and 3.1.2 the candidates' responses indicated a lack of theoretical knowledge as well as practical application on conducting sound and file tests to identify various metals.
- (b) In Q3.4 majority of the candidates described the factors of heat-treatment of steel instead of describing specific steps in the tempering process of steel.

Suggestions for improvement

- (a) Learners should be exposed to different tests used to identify various metals.
- (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) Most of the multiple-choice questions were incorrectly answered due to a lack of content knowledge by candidates.
- (b) Q4.7 was poorly answered as most candidates were unable to use the formulae to calculate the brake power.
- (c) Q4.11 and Q4.12 were incorrectly answered due to the lack of practical knowledge regarding automatic transmission.

Suggestions for improvement

- (a) Learners should be able to distinguish between the different components of an automatic gearbox and to provide the function of each component. This could be enhanced by providing learners with a diagram of an automatic gearbox. Learners are required 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 the majority of the candidates could not label the part marked A to G for the periscope alignment gauge.
- (b) The majority of the candidates could not write the correct sequence required to calibrate the periscope alignment gauge in Q5.1.3.
- (c) In Q5.3 most of the candidates could not state the parameters which can be monitored when using the computerised diagnostic scanner.

Suggestions for improvement

- (a) Learners should to be exposed to all tools as prescribed in the *CAPS* for Automotive. They should be taught the purpose of the tools and be trained to use them correctly. Eventually, learners should be able to identify the different tools.
- (b) Practical skills in performing dynamic wheel balance must be incorporated into the teaching of this content. Teachers need training in the use of specialised tools and equipment, before imparting this knowledge to learners.

QUESTION 6: ENGINES

Common errors and misconceptions

- (a) In Q6.1 some candidates could not identify the parts of the crankshaft.
- (b) In Q6.2.1 to Q 6.2.3 most candidates could not identify the turbocharger, its parts and its function.

Suggestions for improvement

- (a) Teachers must emphasise that there is a clear difference between a turbocharger and a supercharger regarding the parts, functions, operations, advantages and disadvantages.
- (b) Videos and models can be used to demonstrate the operation of both the supercharger and the turbocharger. Teachers should teach the theory and apply it practically for the learners to conceptualise the content.

QUESTION 7: FORCES

Common errors and misconceptions

- (a) Most candidates could not state the types of dynamometers used to measure power output of a motor vehicle in Q7.3.
- (b) In Q7.4.3 the majority of the candidates could not manipulate the formula to calculate the new bore diameter using the original clearance volume in Q7.3.2.

- (c) In Q7.5.1 some candidates could not calculate torque using the information given in the instructions. Candidates 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) 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.
- (b) Discuss each step in the calculation using the formulae. Teachers should illustrate how to do each subcalculation separately indicating the conversion of the unit and then applying the main formulae.
- (c) Making use of a line sketch to define *swept* and *clearance volume*, is useful to enhance understanding of these concepts.
- (d) Teachers are advised to design a worksheet to cater for definitions in respect of terminology involving forces, such as compression ratio, brake power and mechanical efficiency.

QUESTION 8: MAINTENANCE

Common errors and misconceptions

- (a) In Q.8.1 most candidates were not able to differentiate between a *compression test* and a *cylinder leakage test*.
- (b) Many candidates were challenged by Q8.4. They were asked to state four safety measures when conducting a compression test but instead they could only explain how a compression test should be set up.

Suggestions for improvement

- (a) Learners should be able to interpret a manufacturer's specification manual and how to apply the specifications correctly when conducting the compression pressure test and cylinder leakage test. Learners should be allowed to perform the pressure test and record the procedure, in the correct sequence, in point form.
- (b) Teachers should also use video clips related to safety measures when conducting a test.

QUESTION 9: SYSTEMS AND CONTROL (AUTOMATIC GEARBOX)

Common errors and misconceptions

- (a) In Q9.6 the majority of the candidates could not explain the locking sequence of the epicyclic gear train.
- (b) Many candidates did not state the main purpose of the control valve body in an automatic transmission in Q9.7.
- (c) In Q9.8 most of the candidates could not explain the operation of the torque converter in point form.

Suggestions for improvement

- (a) Teachers should use charts to show the labels of the torque converter, its advantages and its operation. If possible, use a sectioned automatic gearbox or an actual vehicle and videos to show learners differences in the operation of the power transmission between automatic and manual vehicles.
- (b) Teachers are advised to design a worksheet that will assist learners to master the function, various parts, purpose, advantages and disadvantages of the automatic transmission.

QUESTION 10: SYSTEMS AND CONTROL (AXLES, STEERING GEOMETRY AND ELECTRONICS)

Common errors and misconceptions

- (a) In Q10.1 many candidates were unable to define static balance of a wheel and tyre assembly.
- (b) The majority of the candidates were unable to identify, define and label the sketch of the wheel alignment angle in Q10.3.1 to Q10.3.3.
- (c) In Q10.4 the majority of the candidates could not state the function of the Ackermann principle.
- (d) Most candidates could not state the purpose of the catalytic converter in Q10.5.
- (e) In Q10.7 some candidates could not explain the operation of the lambda sensor.
- (f) In Q10.8 the majority of the candidates could not state the safety measures when working on an alternator.
- (g) Some candidates were unable to state the types of electrical fuel pump in Q10.9.

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.
- (c) During school-based assessment tasks, learners should be exposed to types of questions which differentiate between the chemical process and the function of the catalytic converter.
- (d) Use an actual alternator to show the components and explain their functions, operation and method to increase its frequency as well as safety measures.
- (e) 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.
- (f) Teachers must spend some time on the explanation of how the lambda sensor operates.

6.2 FITTING AND MACHINING

The following report should be read in conjunction with the Fitting and Machining question paper of the December 2020 examinations.

6.2.1 PERFORMANCE TRENDS (2018-2020)

In 2020, 1 914 candidates sat for the Fitting and Machining examination. This was the third examination of the specialisation subjects. The performance of the candidates in 2020 reflects a good achievement, with 96,8% of the cohort passing at the 30% level and above.

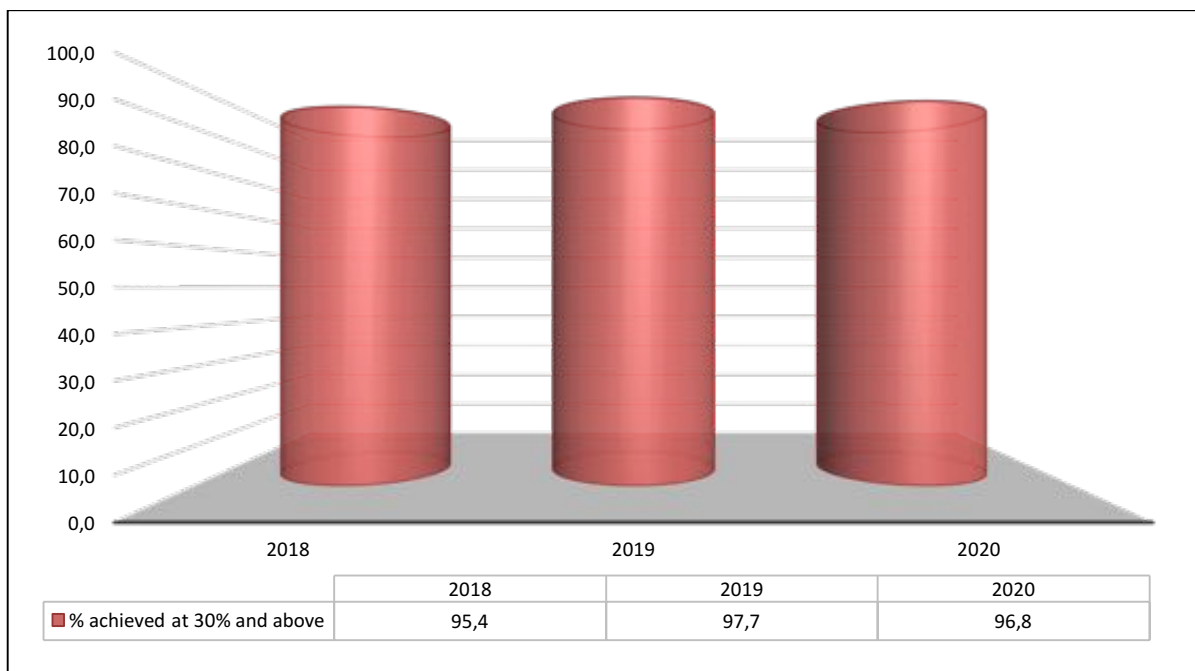
The level of the results may improve in the future with stability in the curriculum as well as with the teachers becoming familiar with the assessment style of the subject.

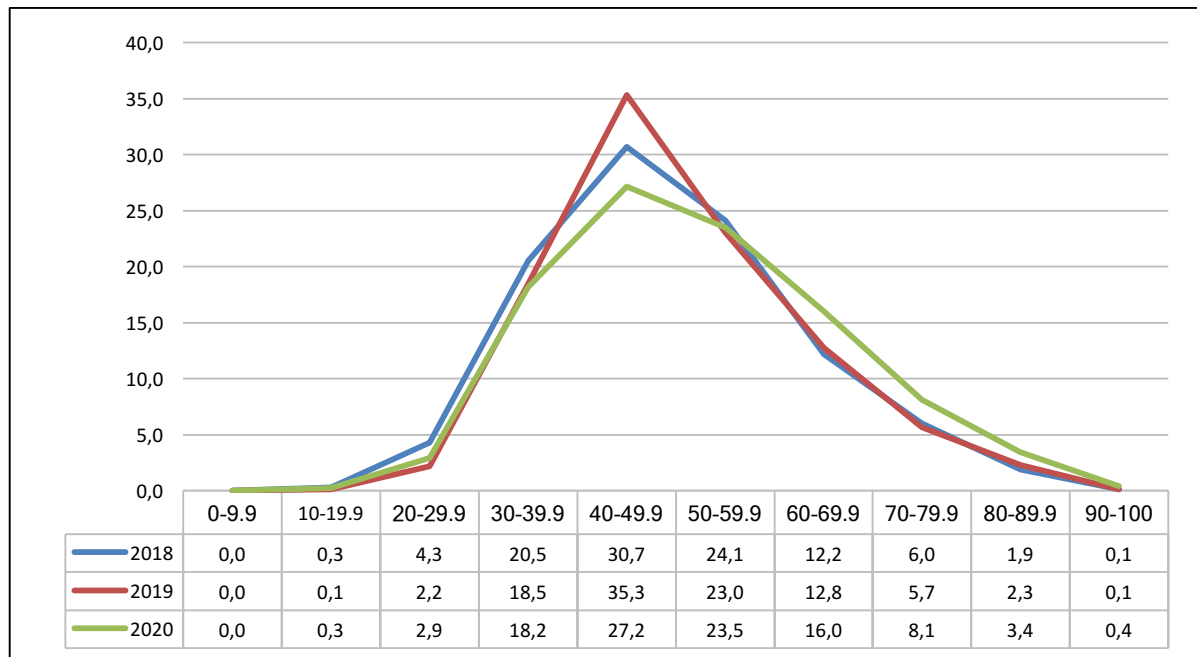
Table 6.2.1 Overall achievement rates in Fitting and Machining

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

There is still room for improvement in the performance of the learners if the challenges surrounding problem-solving skills, mathematical skills, conceptual understanding and integration of topics are addressed. In this regard, integrated problem solving must become an integral part of teaching and learning.

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)

6.2.2 OVERVIEW OF LEARNER PERFORMANCE IN THE FITTING AND MACHINING PAPER

General comments

- (a) The majority of the questions pertaining to pure recall of content were very poorly answered. 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) Candidates did not manipulate formulae correctly. Teachers must emphasise the following: use of the relevant formulae provided on the formula sheet, correct substitution therein and providing 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 candidates. A variety of questions from easy to difficult, in problem-solving activities that involve mathematical knowledge pertaining to the manipulation of formulae and the application of trigonometry, should be used as classwork, homework, tests and examinations.
- (d) Candidates' handwriting should not be too small and calculations should not be cramped onto one section of the page. Candidates should ensure that their work is legible and neatly presented and they should also be able to follow the instructions on the cover.
- (e) Learners need to be taught language skills in order to distinguish among terms such as 'before', 'during', 'while' and 'after' relating to safety applications.
- (f) It appears that candidates do not read questions carefully and consequently do not answer certain sub questions appropriately.

- (g) A lack of knowledge of, or exposure to the use of various tools and equipment, was revealed by candidates.
- (h) Teachers should use previous NSC examination papers as support material and as exercises in the classroom, especially when training learners to answer multiple-choice questions.
- (i) Teachers are advised to use resources, such as video clips, charts, PowerPoint presentations and additional textbooks to illustrate the relationship between content and real-life situations.
- (j) If time constraints are experienced due to disruptions (like the Covid-19 pandemic), practical and theory tasks could not be integrated in teaching and learning.
- (k) Integration of content from other subjects, such as Mathematics, Technical Mathematics, Physical Sciences, Technical Sciences and Engineering Graphics and Design will benefit learners.
- (l) Teachers and subject advisors should develop an item bank of questions and answers. Such questions should assess factual content, calculations and drawings.
- (m) To ensure that the curriculum is covered timeously, supervision and moderation by SMTs and/or PEDs is essential.
- (n) Teacher training needs to focus on the setting of examination papers according to cognitive levels (tests and examination). Sufficient resources are available for this purpose.
- (o) Teacher training should focus on content knowledge in addition to practical training.
- (p) Funding should be made available by the PED, to all schools offering practical assessment tasks which is strictly meant for the purchase of consumable materials.
- (q) Schools need to adhere to the notional time when setting timetables. Double periods should be allocated for practical tasks.
- (r) Schools and the PED need to support teachers with resources. It became clear in the responses from the learners that they have no idea of what some of the tools and equipment look like because they are not available in the workshops at school.
- (s) The candidates of 2020 were most disadvantaged due to lack of contact between teacher and learners. The candidates' responses to most questions was a clear indication that little or no teaching had taken place. This may have been due to many teachers on comorbidity leave, Covid-19 positive or deceased, with no replacement teacher in place, as well as the period of the lockdown.
- (t) Most candidates did not have the opportunity to participate in on-line classes because of poor internet connectivity or non-availability of resources (including data).
- (u) Candidates found it difficult to do self-study because of all the technological terminology and practical applications.

6.2.3 ANALYSIS OF LEARNER PERFORMANCE IN EACH QUESTION IN FITTING AND MACHINING

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Common errors and misconceptions

- (a) In Q1.4 most of the candidates could not identify the correct properties of materials.
- (b) The majority of candidates did not know the purpose of the *tempering of steel* in Q1.5.

Suggestions for improvement

- (a) Teachers should provide worksheets to identify the different properties of materials and then practically demonstrate these properties in the workshop.
- (b) Ensure in-depth revision and remedial measures 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 apply their practical knowledge in theory questions. Learners should be taught 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.
- (c) Teachers must use practical demonstrations to explain the definitions for the properties of steel.

QUESTION 2: SAFETY

Common errors and misconceptions

- (a) Q2.2 specifically asked for safety precautions that must be observed *after* the horizontal band saw has been switched on but instead candidates provided general safety precautions which included precautions that must be observed before and during the operation of a machine.
- (b) In Q2.3 some candidates did not know that by using surgical gloves, a person can prevent infection and protect the wound against contamination.
- (c) Some candidates did not read question Q2.5 carefully regarding the responsibilities of the employer for safety and health.
- (d) In Q2.6 the majority of the candidates incorrectly stated the person responsible to administer first aid.

Suggestions for improvement

- (a) Learners need to read the question with understanding, as some learners tend to write down what comes to mind regarding the topic but not specifically what is required by the question.
- (b) Learners should be exposed to workshop practice relating to the safety of tools, the equipment in the workshop and the workshop environment.

- (c) When using tools and equipment, demonstrate the importance of using surgical gloves when someone cuts themselves. Video presentations and demonstrations would give learners an advantage when answering these types of questions on first aid. Also state who is responsible to administrate / administer first aid.
- (d) Teachers should provide worksheets to differentiate between the responsibilities of the employer and the employee with regard to safety in the workshop.

QUESTION 3: MATERIALS

Common errors and misconceptions

- (a) In Q3.1.1 and 3.1.2 the candidates' responses indicated a lack of theoretical knowledge as well as practical application on conducting sound and file tests to identify various metals.
- (b) In Q3.4 the majority of the candidates described the factors of heat-treatment of steel instead of describing specific steps in the tempering process of steel.

Suggestions for improvement

- (a) Learners should be exposed to different tests used to identify various metals.
- (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.
- (b) The majority of the candidates seem to lack proper skills to answer multiple-choice type questions.
- (c) Most candidates did not understand the term *absolute programming* on three-axis digital read-out system.
- (d) Many candidates seem to lack proper knowledge of the definitions of terminologies regarding stress, strain, break stress and safety factor.

Suggestions for improvement

- (a) Learners must be taught 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 explain the main difference between *absolute* and *incremental programming* on a three-axis digital read-out system. A practical demonstration will enhance learners' understanding of this term.

- (c) Teachers should focus on the *definitions* of all *terminology* in the subject during informal as well as formal assessment activities.

QUESTION 5: TERMINOLOGY – LATHE AND MILLING MACHINE

Common errors and misconceptions

- (a) Q5.1.2 required candidates to calculate the included angle of the taper. Many candidates did the calculation only up to $\frac{\theta}{2} = 4,004^\circ$ supposed to $\theta = 8^\circ$.
- (b) Q5.1.3 requested the angle of the compound slide. Only a few candidates managed to give the correct answer.
- (c) Answers to Q5.1 revealed that candidates lacked the mathematical skills required to answer the question.
- (d) Q5.3 and 5.4 were based on the theory of the practical application of skills regarding the milling processes. The candidates who did not perform well could not relate this to the content in practice.
- (e) Another reason for the poor performance in Q5.3 was the fact that the formula was not given in the formula sheet. However, some candidates managed to formulate or derive the formula from the diagram that was given in the question.
- (f) Most of the candidates responded with poor unlabelled drawings of the straddle milling method.

Suggestions for improvement

- (a) The subject teacher needs to integrate relevant sections with Mathematics (trigonometric equations) and Technical Mathematics.
- (b) Teachers should give learners more activities with different questioning techniques such as substitution, manipulation of formulae and calculations.
- (c) Learners should practise using previous question papers.
- (d) Performing practical tasks can assist learners to understand the concepts and processes. This should assist learners in answering the questions better.
- (e) Teachers must insist that the drawing of all milling processes is done according to the required standard. Learners must use drawing instruments and label the drawing.
- (f) Mathematical skills can only improve with practice. Use the steps as 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) In Q6.1.3 and 6.2.1 the majority of the candidates did not give the final answers for indexing. (No full turns and 40 holes on the 51-hole circle) and (No full turns and 12 holes on the 24-hole circle).
- (b) Q6.2.2 required the candidates to calculate change gears, unfortunately very few candidates could perform the calculation.
- (c) Candidates still struggle with basic *fraction* calculations.
- (d) Question 6.3 required the candidates to calculate dovetail dimensions and the majority of the candidates could not answer correctly.

Suggestions for improvement

- (a) The subject needs to be integrated with Mathematics and Technical Mathematics. Teachers must give learners more activities with different questioning techniques such as substitution, manipulation of formulae and calculations.
- (b) Use diagrams (separate triangles) for the dovetail calculations.
- (c) Give learners practical exposure to the machines and equipment. Explain the calculation while doing the practical tasks.

QUESTION 7: TOOLS AND EQUIPMENT

Common errors and misconceptions

- (a) Some drawings of the hardness tests in Q7.1 were not clear and not labelled.
- (b) This question was based on the theory of the practical application of skills regarding the testing of material and measuring skills. The candidates who did not perform well could not make reference to the content in practice.
- (c) Q7.2 expected the definition of the function of the tensile tester and not a list of the properties determined by the tester, as provided by many candidates. This was a definition directly from the text book.
- (d) Q7.4 required the properties. This mistake brings us back to the fact that the candidates did not read the question with enough care.

Suggestions for improvement

- (a) Teach the drawing of all testing processes according to a standard. Unclear freehand drawings should not be accepted at any stage in the teaching and learning process. The use of drawing instruments and labelling is important when drawing diagrams.
- (b) Teachers should make 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 know the names and uses of the tools that they are using. Teachers can create practical tasks to improve measuring skills using Vernier callipers and micrometers.

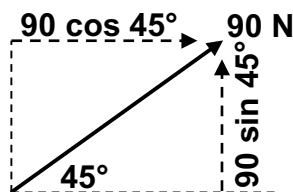
QUESTION 8: FORCES

Common errors and misconceptions

- (a) In Q8.1 the majority of the candidates ignored the hint provided in the question. There was an improvement in the response to this question, although many candidates struggled with the direction needed in the final answer. (North of East)
- (b) Q8.2 required the distance and not the usual force. This created a challenge for some candidates.
- (c) Many candidates did not convert to the correct units before completing the calculation, for example millimetres to meters.
- (d) Many candidates still do not calculate the area of an object before calculating the stress in the material. A number of candidates did not realise that they are busy with a rectangular area (30 x 16 mm) and used the formula for a round area.
- (e) Calculations with exponents, in Q8.3 were a great challenge for the candidates. They were unable to state the required units of measure. Furthermore, candidates were not able to work with formulae on stress calculations.

Suggestions for improvement

- (a) Drawing a diagram will assist candidates in determining the formulae as shown below.



- (b) Learners should be encouraged to perform calculations systematically according to the following steps:
- 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
- (c) Learners must ensure to use exponents and the correct unit in the answer.
- (d) Different methods of calculations 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.
- (e) Different areas must be practised during homework and assessments.

QUESTION 9: MAINTENANCE

Common errors and misconceptions

- (a) All questions, except Q9.1, Q9.2 and Q9.4 were poorly answered. This has caused the overall poor performance in this question. It was evident that this content was not adequately covered or at all, in some cases.
- (b) This section consists mostly of factual information and most of candidates' responses showed a lack of knowledge and understanding in this topic.
- (c) The majority of the candidates' answers indicated a lack of practical experience in respect to maintenance.
- (d) Most of candidates had difficulty giving a reason or providing an explanation or stating a procedure, 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) Maintenance procedures cannot be learnt from a book or notes. It has to be observed or performed in practice. Teachers can design 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 taught.
- (c) The integration of theory and practice in the workshop is imperative.

QUESTION 10: JOINING METHODS

Common errors and misconceptions

- (a) Many candidates displayed a lack of knowledge and understanding of the definitions relating to screw thread terminology (pitch diameter/pitch circumference).
- (b) The majority of the candidates generally lack mathematical skills that are necessary for questions.
- (c) There was evidence that many candidates did not work systematically through the question. They found it difficult to complete a calculation which had to be applied in a subsequent calculation in order to determine the final answer on the specific question. (First calculate *Pitch Diameter* then *Pitch Circumference* and then *Helix Angle*).
- (d) Most of the candidates lost marks when the first part of the calculation was incorrect, which caused the candidate to lose more marks in the follow-up calculations. e.g. 10.1.1–10.1.4. (11 marks).

Suggestions for improvement

- (a) Teachers need to make sure that learners know and understand the screw thread terminology.
- (b) Learners should practise calculations more to gain confidence in answering this type of question.

- (c) Learners should work systematically through the calculations according to the following steps:

- Formula
- Formula manipulation (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. This is possibly due to the topic being placed towards the end of the year on the ATP, and educators had to cope with the time constraints imposed by COVID-19 disruptions.
- (b) This section is a higher-order section and most candidates struggled with systems and control calculations.
- (c) Q11.2, Q11.3 and Q11.4 were answered very poorly due to a lack of mathematical skills. Candidates lost marks because when the first calculation was incorrect, subsequent calculations would also be incorrect, e.g. Q11.3.1–Q11.3.2.
- (d) Many candidates were able to apply the formulae correctly but expressed the answer in the incorrect unit of measure.
- (e) In Q11.4 many candidates did not calculate the *product* of the number of gear teeth, they calculated the *sum* of the number of gear teeth, which was not a requirement of the question. This was a common mistake amongst many candidates.
- (f) In Q11.2.1, 11.2.2, 11.2.3, 11.3.2 and 11.4 candidates were not able to give the answer in the required unit (r/sec, kW, m.s^{-1} , mm and r/min)

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 in understanding the content. The subject needs to be integrated with Mathematics, Technical Sciences and Technical Mathematics.

6.3 WELDING AND METALWORK

The following report should be read in conjunction with the Welding and Metalwork question paper of the November 2020 examinations.

6.3.1 PERFORMANCE TRENDS (2018-2020)

In 2020, 1 683 candidates sat for the Welding and Metalwork examination. This was the third examination of the specialisation subjects. The performance of the candidates in 2020 reflects a decrease from 2019, with 88,8% of the cohort passing at the 30% level and above.

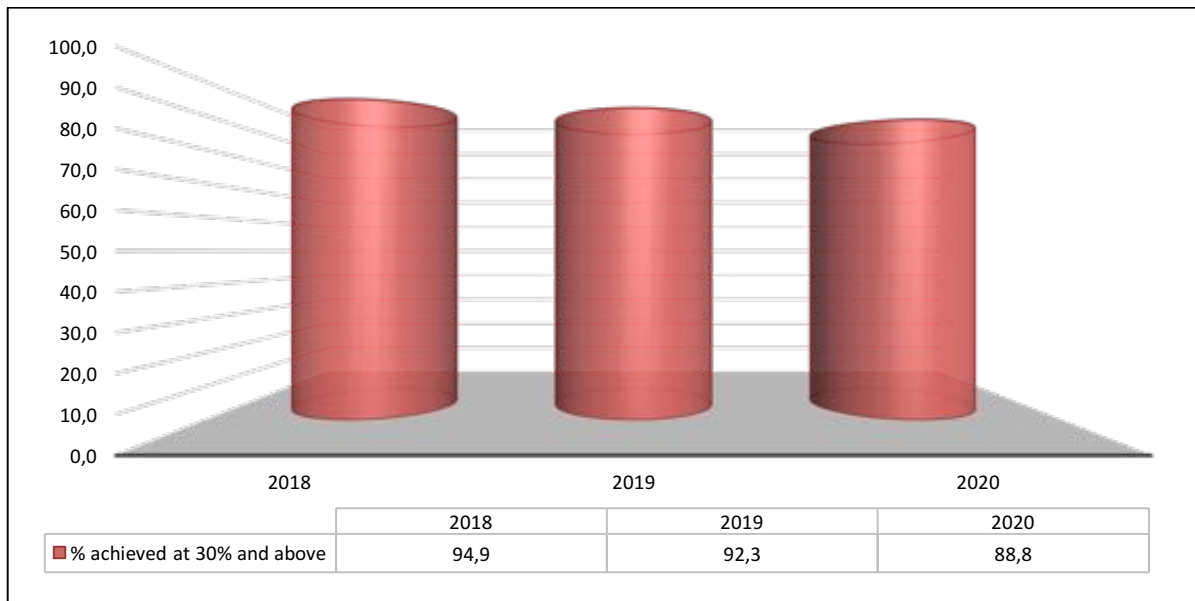
The results may improve in future, with stability in the curriculum and with teachers and learners becoming familiar with the assessment style of the subject.

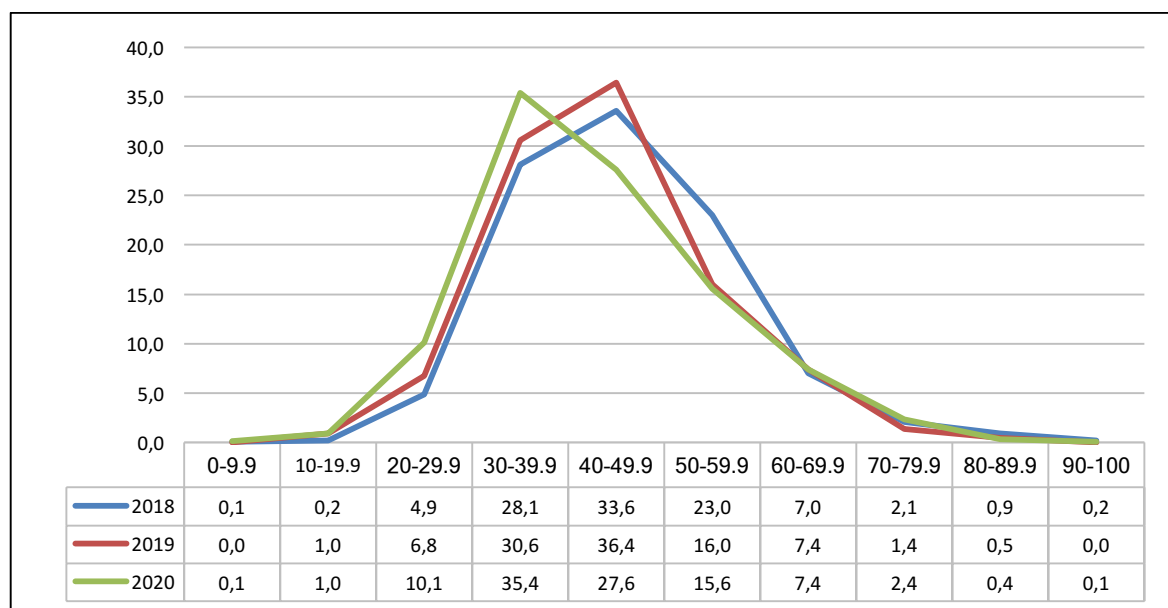
Table 6.3.1 Overall achievement rates in Welding and Metalwork

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

There is still room for improvement in the performance of the learners if the challenges surrounding problem-solving skills, mathematical skills, conceptual understanding and integration of topics are addressed. In this regard, integrated problem solving must become an integral part of teaching and learning.

Graph 6.3.1(a) Overall achievement rates in Welding and Metalwork (percentage)



Graph 6.3.1(b) Performance distribution curves in Welding and Metalwork (percentage)

6.3.2 OVERVIEW OF LEARNER PERFORMANCE IN THE WELDING AND METALWORK PAPER

General comments

- (a) The majority of the questions pertaining to pure recall of content were very poorly answered. 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) Candidates did not manipulate formulae correctly. Teachers must emphasise the following: use of the relevant formulae provided on the formula sheet, correct substitution therein and providing 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 candidates. A variety of questions from easy to difficult, in problem-solving activities that involve mathematical knowledge pertaining to the manipulation of formulae and the application of trigonometry, should be used as classwork, homework, tests and examinations.
- (d) Candidates' handwriting should not be too small and calculations should not be cramped onto one section of the page. Candidates should ensure that their work is legible and neatly presented and they should also be able to follow the instructions on the cover.
- (e) Learners need to be taught language skills in order to distinguish among terms such as 'before', 'during', 'while' and 'after' relating to safety applications.
- (f) It appears that candidates do not read questions carefully and consequently do not answer certain sub questions appropriately.

- (g) A lack of knowledge of, or exposure to the use of various tools and equipment, was revealed by candidates.
- (h) Teachers should use previous NSC examination papers as support material and as exercises in the classroom, especially when training learners to answer multiple-choice questions.
- (i) Teachers are advised to use resources, such as video clips, charts, PowerPoint presentations and additional textbooks to illustrate the relationship between content and real-life situations.
- (j) If time constraints are experienced due to disruptions (like the Covid-19 pandemic), practical and theory tasks could not be integrated in teaching and learning.
- (k) Integration of content from other subjects, such as Mathematics, Technical Mathematics, Physical Sciences, Technical Sciences and Engineering Graphics and Design will benefit learners.
- (l) Teachers and subject advisors should develop an item bank of questions and answers. Such questions should assess factual content, calculations and drawings.
- (m) To ensure that the curriculum is covered timeously, supervision and moderation by SMTs and/or PEDs is essential.
- (n) Teacher training needs to focus on the setting of examination papers according to cognitive levels (tests and examination). Sufficient resources are available for this purpose.
- (o) Teacher training should focus on content knowledge in addition to practical training.
- (p) Funding should be made available by the PED, to all schools offering practical assessment tasks which is strictly meant for the purchase of consumable materials.
- (q) Schools need to adhere to the notional time when setting timetables. Double periods should be allocated for practical tasks.
- (r) Schools and the PED need to support teachers with resources. It became clear in the responses from the learners that they have no idea of what some of the tools and equipment look like because they are not available in the workshops at school.
- (s) The candidates of 2020 were most disadvantaged due to lack of contact between teacher and learners. The candidates' responses to most questions was a clear indication that little or no teaching had taken place. This may have been due to many teachers being on comorbidity leave, Covid-19 positive or deceased, with no replacement teacher in place, as well as the period of the lockdown.
- (t) Most candidates did not have the opportunity to participate in on-line classes because of poor internet connectivity or non-availability of resources (including data).
- (u) Candidates found it difficult to do self-study because of all the technological terminology and practical applications.

6.3.3 ANALYSIS OF LEARNER PERFORMANCE IN EACH QUESTION IN WELDING AND METALWORK

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Common errors and misconceptions

- (a) In Q1.4 most of the candidates could not identify the correct properties of materials.
- (b) The majority of candidates did not know the purpose of the *tempering of steel* in Q1.5.

Suggestions for improvement

- (a) Teachers should provide worksheets to identify the different properties of materials and then practically demonstrate these properties in the workshop.
- (b) Ensure in-depth revision and remedial measures 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 apply their practical knowledge in theory questions. Learners should be taught 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.
- (c) Teachers must use practical demonstrations to explain the definitions for the properties of steel.

QUESTION 2: SAFETY

Common errors and misconceptions

- (a) Q2.2 specifically asked for safety precautions that must be observed *after* the horizontal band saw has been switched on but instead candidates provided general safety precautions which included precautions that must be observed before and during the operation of a machine.
- (b) In Q2.3 some candidates did not know that by using surgical gloves, a person can prevent infection and protect the wound against contamination.
- (c) Some candidates did not read question Q2.5 carefully regarding the responsibilities of the employer for safety and health.
- (d) In Q2.6 the majority of candidates incorrectly stated the person responsible to administer first aid.

Suggestions for improvement

- (a) Learners need to read the question with understanding, as some learners tend to write down what comes to mind regarding the topic but not specifically what is required by the question.
- (b) Learners should be exposed to workshop practice relating to the safety of tools, the equipment in the workshop and the workshop environment.

- (c) When using tools and equipment, demonstrate the importance of using surgical gloves when someone cuts themselves. Video presentations and demonstrations would give learners an advantage when answering these types of questions on first aid. Also state who is responsible to administrate / administer first aid.
- (d) Teachers should provide worksheets to differentiate between the responsibilities of the employer and the employee with regard to safety in the workshop.

QUESTION 3: MATERIALS

Common errors and misconceptions

- (a) In Q3.1.1 and 3.1.2 the candidates' responses indicated a lack of theoretical knowledge as well as practical application on conducting sound and file tests to identify various metals.
- (b) In Q3.4 the majority of the candidates described the factors of heat-treatment of steel instead of describing specific steps in the tempering process of steel.

Suggestions for improvement

- (a) Learners should be exposed to different tests used to identify various metals.
- (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) In Q4.14 some candidates were not familiar with principle 3.4.5 as used in the Pythagoras theorem.

Suggestions for improvement

- (a) Teachers should give learners more practice to calculate Pythagoras theorem and trigonometric ratios.

QUESTION 5: TERMINOLOGY

Common errors and misconceptions

- (a) Q5.2 required candidates to state the use of the templates made from thin material and hardboard. Most candidates provided examples of general template use.
- (b) Q5.5 required candidates to state what SANS stands for. The majority of the candidates could not give the meaning of the abbreviation.
- (c) In Q5.7 candidates were required to explain welding symbols. Most candidates were unable to interpret the welding symbols.

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 question at hand.
- (b) Teachers should familiarise learners with the codes of practice for welding which are stated in the South African National Standards.
- (c) More practical exposure will improve the performance in written assessments. Use welding symbols in the PAT drawings. Practical application of theory will help understanding and remembering of the content.

QUESTION 6: TOOLS AND EQUIPMENT

Common errors and misconceptions

- (a) In Q6.2 many candidates were not able to describe the working principles of machines as opposed to their uses. In some instances, candidates gave safety measures instead of operating principles.
- (b) Q6.3 required candidates to give functions of flashback arrestors. The majority of the candidates did not know the definition of the flashback arrestor.

Suggestions for improvement

- (a) Teachers should emphasise the difference between working principles and the function and safety of machines. Learners should work on the machines to gain a practical experience the work.
- (b) Teachers should show learners the practical operation of the equipment.

QUESTION 7: FORCES

Common errors and misconceptions

- (a) In Q7.1 the majority of the candidates could not draw force diagrams correctly.
- (b) Most of the candidates had difficulty in calculating the bending moments as well as drawing bending moments and shear force diagrams in Q7.2.
- (c) Most candidates were unfamiliar with calculations related to stress and safe working stress that were required in Q7.3.1 and Q7.3.

Suggestions for improvement

- (a) Learners must perform many examples and continuously practice their drawing skills.
- (b) Learners should be exposed to more exercises related to the bending moments and shear force diagrams.
- (c) Learners should practise their mathematical skills. Supporting subjects like Mathematics, Technical Mathematics and Technical Sciences should emphasise relevant sections related to forces.

QUESTION 8: JOINING METHODS – WELD INSPECTION

Common errors and misconceptions

- (a) In Q8.3 the majority of candidates had difficulty in differentiating causes of weld defects between porosity and poor penetration.
- (b) Many candidates were unfamiliar with the causes of cracks in the Heat Affected Zone in Q8.4. They responded to causes of cracks in general.
- (c) In Q8.6 some candidates had difficulty in describing procedures to be followed when performing an ultrasonic test on a welded joint.

Suggestions for improvement

- (a) Teachers should expose learners to practical work in order to bring the subject matter closer to the learner.
- (b) Teachers should use previous papers for revision and preparation for examinations.
- (c) Teachers should use videos and other electronic media during the 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 did not understand the effect of working on steel in its hot state. They responded on how heat treatment is being done.
- (b) Many candidates had difficulty in labelling the iron-carbon equilibrium diagram in Q9.3.
- (c) In Q9.4 the majority of candidates had difficulty in explaining the effect of cooling metal rapidly. They responded on how case hardening is done where the metal is cooled rapidly.

Suggestions for improvement

- (a) Learners should be exposed to videos during lessons as well as simulations on the effect of working on steel in its hot state.
- (b) Learners should study this section well as it consists of facts and teachers should conduct thorough revision on this section.
- (c) Teachers should demonstrate practically and through simulations, the effect of cooling metal rapidly.

QUESTION 10: MAINTENANCE

Common errors and misconceptions

- (a) In Q10.2 the majority of the candidates had difficulty in explaining why lock-out is applied to machines during 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.

QUESTION 11: DEVELOPMENT BY CALCULATIONS

Common errors and misconceptions

- (a) In Q11.1-Q11.3 the majority of the candidates were not familiar with calculating true lengths of a square to round transition piece.

Suggestions for improvement

- (a) Subject advisors should provide training workshops to teachers on this topic so as to teach it more effectively. Different methods to derive an answer should be explored as learners may not understand one method but could understand an alternative method.
- (b) The subject needs to be integrated with Mathematics (trigonometric equations), Technical Sciences and Technical Mathematics as serving subjects).

CHAPTER 7

ENGINEERING GRAPHICS AND DESIGN

The following report should be read in conjunction with the Engineering Graphics and Design question papers of the November 2020 NSC Examinations.

7.1 PERFORMANCE TRENDS

This is the first year that Engineering Graphics and Design has been included in the diagnostic report. Statistical information about candidates' performance in questions and sub-questions have not been collected over the years. Consequently, this report does not contain any tables or graphs highlighting performance in the subject. Therefore, no comment is will made about the performance trends in the subject.

7.2 OVERVIEW OF CANDIDATES' PERFORMANCE IN PAPER 1 AND PAPER 2

(a) **Quality of candidates' performance:** The performance of candidates in Paper 1 in the 2020 NSC examination reflected a pleasing improvement in comparison to that of the previous year. However, the same cannot be said about the performance of the candidates in Paper 2.

- The good quality of the responses from many candidates in a number of centres across all the provinces is evidence that teachers at these centres have planned well and prepared their learners adequately to cope with the complexities and the content of the examination. These candidates have illustrated an ability to address the requirements of the questions, to extract and use the relevant information appropriately and to manage their time effectively.
- All questions in both the Engineering Graphics and Design papers are designed to be accessible to all candidates, at least in part. The inability of weaker candidates to effectively deal with even the less challenging parts of questions, is a clear indication of deficiencies in the teaching and learning processes. If basic concepts and procedures are not being properly addressed at an early stage, this will subsequently impact negatively on exam performance.

(b) **Pertinent factors that cause poor results:**

The poor results in many centres have exposed the fact that challenges in teaching and learning are still prevalent. The following factors continue to be identified as reasons for poor performance:

- **Language barriers linked with poor comprehension skills:** Many candidates appear to find it difficult to understand and address the requirements of questions adequately. Responses are often not in line with the requirements of the questions. Weaker candidates provide incomplete responses. The format of many questions in both papers have remained the same from year to year with only the requirements or specifications being altered. Learners need to be taught to '*read with meaning*'.

- **Inability or laziness in reading the questions to identify relevant information:** The standard structure of an Engineering Graphics and Design question remains relatively constant. Candidates are expected to sift through and extract the relevant information as required. Weaker candidates often find this very challenging, giving the impression that they simply look at the graphics and then appear to make an assumption on what the question should be.
- **Planning an answer:** This often goes hand in hand with not reading the question and understanding what is required resulting in candidates rushing to start answering a question without planning their answer, only to find out too late that they have not left sufficient space on the drawing sheet to place the required views.
- **Lack of meaningful revision of relevant Grade 10 and 11 Content:** Every examination question contains content from previous Grades that is pertinent to Grade 12. It is vital that these aspects from previous grades are constantly reinforced in Grade 12. It is advised that especially the weaker learners must practise the fundamental aspects of the curriculum, and teachers should factor these aspects into their intervention programmes or the informal assessment programme. In light of this, the use of workbooks should be discouraged as the learner derives no benefit from using them. As convenient as it may be for the teacher to use prepared drawing sheets, it removes practice in fundamental aspects of the curriculum and often the access to answering a question in an examination.
- **Lack of formative testing:** Teachers are expected to plan and implement an informal assessment programme to support the formal assessment tasks or course drawings. 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 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 ability to draw quickly and accurately, 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

Teachers are expected to plan before the school year starts, due to the limited instruction time in each term. It is essential that they build the following practices into their work plans:

- (a) **Understanding and planning:** In order for the learner to know what is required, a question must be read and understood, in other words, read with meaning. Teachers need to address 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 that instructions in a question in Engineering Graphics and Design are to the point and must be read.

- Often poor or incorrect answers result from learners not taking note of the specific requirements of questions. This is a common problem in current times when skim-reading off screens is a widespread habit.
 - Teachers are advised to repeat the process of interpreting and analysing a structured exam question with their classes at appropriate times during the Grade 10-12 academic years as follows: (1) Read each word of the instruction with their learners (2) Underline or highlight key words or instructions (3) Identify where it would be most appropriate to start preparing an answer (4) Identify where the relevant source information is placed.
- (b) **Policy documents and LTSM:** It is essential that every teacher is in possession of the revised CAPS document, the latest *Examination Guidelines*, DBE approved textbooks and the SANS 10111 and SANS 10143 codes of practice. These must form the basis of the planning and teaching process.
- (c) **Use of past NSC examination papers:** Past question papers serve as one of many teaching and learning resources and must be incorporated in the planning and teaching process. Every learner must have access to past examination papers, as these are based on the current CAPS content and provide a reliable trend on questioning patterns and style.
- (d) **Time management:** Training on time management must be an on-going process. This must apply to short summative informal activities, controlled tests and examinations. Examination questions provide time guides, and learners must practise the skill of adhering to the suggested time allocations. They must also be made aware that the mark allocation must be linked to the length of time spent on an answer.
- (e) **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 time allocated, learners must be '**drawing fit**' and this is only achieved through physically drawing and more especially, setting time limits.
- (f) **Essential prior knowledge:** The teaching of every topic should commence by revising or introducing the basic concepts and terminology pertaining to that topic to ensure that learners are able to construct connections between old and new knowledge.

7.3 ANALYSIS OF CANDIDATES' PERFORMANCE IN INDIVIDUAL QUESTIONS IN PAPER 1

QUESTION 1: CIVIL ANALYTICAL

Candidates generally performed well when answering the first few questions. These questions are intended to be less challenging as the candidate simply read the answer off the drawing if the candidate knew where to find the information.

The middle set of questions were less predictable and therefore more challenging as these required more application of knowledge.

The last few questions are regarded as, and are intended to be, more challenging as they examine mathematical concepts and SANS content. Although this type of question is

reasonably predictable, the responses remain disappointing.

The questions covered a variety of civil concepts and in particular the site plan and a title panel. Most of the questions were generally well answered by the more capable candidates, but weaker candidates continued to be challenged with these topics. The more capable learners were, however, able to show insight and understanding and earned good marks.

Common errors and misconceptions

Many candidates found Q1.18, Q1.19 and Q1.20 to be most challenging.

- (a) Attention to detail is an important acquired skill in Engineering Graphics and Design. This skill was tested in Q1.18. (3 marks). In calculating the length of the precast fence, candidates had to understand the basic mathematical concept of adding the given lengths. Then candidates had to identify that the pre-cast fence was situated along the boundary line. Finally, there was a 3,5 m sliding gate situated on the south western section of the fence that had to be subtracted from the total. Many candidates had could not answer this question correctly because they neglected to pay attention to the details in the question.
- (b) Determining the total area of a building, or 'the proposed new flatlet' as asked in Q1.19 (3 marks), is not an unfamiliar concept. It was disappointing to see that many candidates still experienced difficulty in dividing the shape of the flatlet into workable portions and applying the basic mathematical formula of *area = length x breadth*.
- (c) The content of the *SANS 10143 code of practice for building drawing* is fundamental to the content of paper 1. The answer to Q1.20 (4 marks) required candidates to recall the graphical symbol for a *STALL TYPE URINAL*.
- (d) When candidates are expected to draw in *neat freehand*, neatness and proportion are two fundamental requirements that are expected to be adhered to as these go hand-in-hand with freehand drawing. Candidates overlooked these criteria when making free-hand drawings.

Suggestions for improvement

- (a) Examiners will always strive to be restrictively creative within a question in order to balance the predictable nature of this question. Teachers are advised to provide a variety of examples to learners to expose them to the different questioning techniques on this topic.
- (b) Learners must practise applying the mathematical formulas for determining area and perimeter. These two calculations can be reinforced by giving learners short formative tests regularly and will also serve as useful revision of work.
- (c) The teacher must be in possession of the *SANS 10143 code of practice for building drawing* and regularly refer to the contents. Once again the content can be reinforced by giving learners short formative tests which will also serve as useful revision of work.
- (d) The quality of the candidate's line work in freehand drawing and drawing skill is assessed in the PAT and not in the NSC examination. This does not imply that freehand work should be poorly presented 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. This also applies to printing.

QUESTION 2: SOLID GEOMETRY

There were centres in all the provinces where a large percentage of the candidates performed well above the average, however, there were also centres in all the provinces where the candidates appeared to be challenged.

It is important to note that the question was designed to allow the weaker candidates to project all three views of the less complicated square pyramid, whereas the stronger and more abled candidate should have been able to draw the inverted, rotated hexagonal pyramid and the square pyramid. This is the design aspect of the question and where the cognitive levels come into play.

Common errors and misconceptions

- (a) Too many candidates were unable to differentiate between first-angle and third-angle orthographic projection. Whether this is a reading problem, a planning problem or a lack of understanding of the concept of orthographic projection, we will never know.
- (b) Drawing polygons is a Grade 10 topic while rotating a polygon is a Grade 11 topic, yet many of the weaker candidates could not start the drawing because they could not draw a rotated hexagon. This is possibly because the teacher is using prepared answer sheets which have the 'easy' part of the drawing already prepared for the candidate. This would imply that the last time a candidate may have constructed a hexagon could have been in Grade 10. There were far too many candidates who could not draw the rotated regular hexagon, with weaker candidates seemingly not even able to draw a square correctly.
- (c) Apart from the knowledge aspect needed to answer a solid geometry question there is also technique. The weaker candidate should attempt to draw and project one of the solids rather than ignoring the question altogether.

Suggestions for improvement

- (a) Teachers who are spotting which of the three topics is most likely to appear in the examination must stop this practice immediately. You may have been successful once or twice before but more often you will get it wrong and this will be to the detriment of your learners.
- (b) Ongoing and regular practice of the basics are essential in developing and maintaining a high level of skill and the ability in solid geometry.
- (c) The teaching of every topic should commence by revising or introducing the basic concepts and terminology pertaining to that topic to ensure that learners are able to make connections between old and new knowledge. If you get the basics right, the more challenging concepts will follow.
- (d) It is important that the teacher regularly emphasizes the difference between first-angle and third-angle orthographic projection. It is also imperative that the teacher, as early as in Grade 10, emphasizes the importance of first reading the question, then understanding what has to be drawn and finally to plan the positioning of the views.
- (e) The use of prepared answer sheets must be discouraged as it often diminishes the candidates' ability to attempt an answer because they have not had regular practice in preparing the basic elements of the drawing.

- (f) Teachers need to address poor drawing practices before these become an issue which cannot be fixed. This must be done from Grade 10 through to Grade 12.
- (g) 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 on damage control prior to examinations.

QUESTION 3: PERSPECTIVE DRAWING

Common errors and misconceptions

- (a) Many candidates were unable to determine the correct position of the two vanishing points with the result that whatever they drew from that point on would be incorrect.
- (b) Determining the height line, and in some cases there could be more than one height line depending on the number of edges in the picture plane, is another fundamental concept to determining the correct receding height of objects.
- (c) The complexity of the drawing increases as the drawing is built up by the ever-increasing number of lines used to find the points in perspective. The candidate needs to work systematically through the drawing so that they do not waste time determining the same points multiple times.
- (d) Projecting a semi-circle is a complex process which requires in-depth knowledge and skills to project correctly and accurately. This should not prevent the weaker candidate from dividing up the views of the arc into 30° segments, demonstrating some knowledge.

Suggestions for improvement

- (a) Vanishing points are projected off the *SP*, **parallel** to the **inclined edges** of the **top view** of the object (either 30°/60° or 45°), to the *PP*. At the point of intersection, they are then projected perpendicularly downwards to meet the *HL*. They must then be neatly labelled *VPL* on the left and *VLR* on the right. The teacher must ensure that all learners are able to execute the basics.
- (b) 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 the method of moving the object to the correct position by joining the heights to the correct vanishing point.
- (c) It is imperative that the teacher 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.
- (d) The teaching of the fundamentals of perspective drawing along with methodology and terminology pertaining to that topic is essential. Ongoing and regular practice is necessary in developing and maintaining a high level of skill and the ability to draw accurate and neat perspective drawings.

QUESTION 4: CIVIL AND ELECTRICAL ASSEMBLY**Common errors and misconceptions**

- (a) It must be noted that weaker candidates seemed to perform better in this question than many of the other questions in the paper, however, there were still far too many candidates who make elementary errors.
- (b) There are tables on the question sheet that contain information that the candidates must use. The relevant electrical symbol must simply be selected from the table and copied incorrectly across onto the drawing, whereas the candidate must know the *SANS 10143* graphical symbol for the fixtures and apply them using the dimensions given in the fixtures table.
- (c) Hatching patterns used to differentiate the various elements in the sectional elevation are once again contained in the *SANS 10143*. Teachers and candidates are also able to access past *NSC* papers on the DBE website for reference purposes.
- (d) The detail of a roof is Grade 12 content. There were 12 elements assessed on the roof in the detailed sectional view, (roof angle, roof sheet, purlins and spacing, truss and overhang, fascia board, wall plate bracing and spacing, ceiling board and the gutter). This was not well answered with many candidates. They either left off components or drew them to the incorrect size. This is an indication that they either did not read the part of the question correctly or did not know the structure of the roof.

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 10143 code of practice for building drawing*, DBE approved textbooks and past *NSC* exam papers.
- (b) Course drawings must be set at an appropriate level so that learners can engage meaningfully with work at and at the required level.
- (c) The basic format of this question is standard. One of the underlying problems is that it is covered very early in the year. Learners must be given regular revision drawings throughout the year to prepare them for end of the year.
- (d) The weaker candidates must be advised to start the drawing by completing the floor plan and correctly including all the required elements. These include neatly printing the room designations and floor finishes, correctly drawing in the doors and windows to the correct size, adding the electrical layout and filling in the hatching detail correctly.
- (e) All drawings must be prepared using the correct instruments and learners must be able to use them correctly. It must be noted that any work presented in freehand, unless specified in the question, like substructure hatching, for example even if correct, is not marked.
- (f) No learner should be expected to sit for an examination without being taught time management. This concept can only be realised by setting course drawings with time constraints and getting the learner to draw within these time constraints.
- (g) Subject advisors must seriously address the issue of language across the curriculum and provide opportunities for teacher development on this matter on an on-going basis.

7.4 ANALYSIS OF CANDIDATES PERFORMANCE IN INDIVIDUAL QUESTIONS IN PAPER 2

QUESTION 1: MECHANICAL ANALYTICAL

Candidates, as in the past, generally performed well when answering the first few questions. The answers to these questions are simply read off the drawing if the candidate knows where to find them.

As the candidates move towards the middle set of questions, the questions become less predictable and more challenging, as they require the application of knowledge. The last few questions are regarded as, and are intended to, challenge the top candidates as they examine *SANS* concepts and content.

As usual, the questions covered a variety of mechanical concepts including the machining symbol and determining a tolerance range. These were generally well answered by the more capable candidates, but weaker candidates continued to be challenged with these topics. The more capable candidates were, however, able to show insight and understanding and earned good marks.

Common errors and misconceptions

- (a) The convention of symmetry (Q1.11; 1 mark) has been asked in many previous papers in different ways. It is disappointing to find that there are so many candidates that appear not to use past NSC examination papers as an aid to revise *SANS 10111*
- (b) Q1.12 (1 mark) was a change in focus of a familiar question and elevating it by asking what type of view is produced by an S-break. This was a higher-order question and was not expected to be answered by the weaker candidates.
- (c) An in-depth knowledge of third angle orthographic projection is needed for Paper 2. If candidates were familiar with methodology behind this system of drawing (Q1.13; 2 marks) which required the candidate to know what type of view is produced by cutting plane S-S, it would not have been challenging.
- (d) It appears as though teachers in many centres across all provinces either do not have, or are not making use of, the *SANS 10111 Code of practice for engineering drawing* or DBE approved textbooks, as reflected by the poor responses of candidates to Q1.17 (1 mark) which required a knowledge of a machining symbol.
- (e) Calculating a tolerance is a basic mathematical process that has been asked before (Q1.18; 1 mark), however, candidates did not read and understand the question carefully before attempting to answer it.
- (f) The content of the *SANS 10111 Code of practice for engineering drawing* is fundamental to the content of Paper 2. The answer to Q1.19 (1 mark) required the candidate to recall the convention for a spring, whereas in Q1.20 (3 marks) specific knowledge of a machining symbol was required. It is worrying to note that after so many years of the drawing system symbol being examined, there are still candidates who cannot produce it.

Suggestions for improvement

- (a) At a glance one notices that the candidates found the higher-order cognitive questions more challenging. It must be noted that the weaker candidates were not expected to be able to answer questions set at the higher cognitive level. Teachers must be conscious about this trend.
- (b) When the candidate is expected to draw in neat freehand, neatness and proportion are two fundamental requirements that are expected to be adhered to as these go hand-in-hand with freehand drawing. The graphic should also be correct in order for marks to be allocated.
- (c) Teachers must address the issue of language across the curriculum by providing opportunities for learners to read with meaning which will help them to understand and apply terminology correctly.
- (d) Teachers must continue to devote more attention to the content of the *SANS 10111 Code of practice for engineering drawing* through regular formative assessment, particularly in the case of weaker candidates.

QUESTION 2: LOCI

There were again centres in all provinces where a large percentage of the candidates performed well above the average with their answers. However, there were also centres in every province where the candidates appeared to be challenged.

It is important to note that both sub-questions were set in such a way as to allow the weaker candidate to answer at least part of the question.

Common errors and misconceptions**Sub-question 2.1: The helix**

- (a) Constructing a chute involves much the same process, but involves constructing 4 parallel helecies. The basics always remain the same no matter how complicated the combination of helecies become. Many of the weaker candidates were unable to construct the basic helix leading to a further problem with constructing multiple helices.
- (b) The direction of rotation of the chute and determining the pitch of the chute was a challenge for many candidates. It is advisable for the candidate to first draw the pitch of one helix before adding on the extra height of the chute to it.
- (c) Marks are allocated for showing the method of dividing the pitch and the circumference of the chute into the required number of parts. It then stands to reason that all construction lines must be shown on the drawing. The weaker candidate lost these marks that were meant for them to achieve.
- (d) Centre lines are an integral part of indicating circular and cylindrical shapes and must be included in the drawing.
- (e) The candidates in many centres did not know how to apply the knowledge of a helix to drawing the chute and displayed little understanding of determining the points needed to draw the helix.

Sub-question 2.2: The cam

- (a) The candidates were only required to draw the displacement graph where the position of the follower was given at its maximum displacement. This resulted in an inverted displacement graph having to be drawn. The weaker candidates did not read the question correctly landing up drawing an inverted graph.
- (b) Dividing the base line of the displacement graph into 12 equal segments is a concept that the weaker candidate should be able to complete together with drawing the dwell and uniform motion sections of the graph. Many candidates appeared unable to perform the basics correctly losing them marks.
- (c) Producing the more complex simple harmonic motion and uniform acceleration and retardation motions on the displacement graph were designed and intended to be answered by the stronger candidate. Both these motions require extra and more advanced construction methods which many of the abled candidates omitted to include with their answers. All construction must be shown on the drawing as marks are allocated for this.
- (d) Although capable candidates were able to score good marks in this question, many of them did not read the question with understanding which was made obvious when they did not follow simple instructions like labelling the graph and indicate the scale.

Suggestions for improvement

- (a) Teachers must refrain from spotting which of the three topics will appear in the examination paper as this can be to the detriment of candidates should the spotting be incorrect.
- (b) Once the basic construction method of preparing a helix is completed, candidates must be taught how to break a question down into manageable pieces. Once this is done, then to start drawing from the simple aspects to the more complicated aspects of a question.
- (c) Ongoing and regular practice of the basics is essential in developing and maintaining a high level of skill and the ability in applying the concepts of producing the three topics in loci.
- (d) The teaching of every topic should commence by revising or introducing the basic concepts and terminology pertaining to that topic to ensure that students are enabled to make connections between old and new knowledge. If you get the basics right, the more challenging concepts will follow.
- (e) Teachers must appreciate that in order for the weaker candidates to achieve a minimum pass mark, they will require more revision material and more regular practice than they are currently getting.
- (f) The use of prepared answer sheets must be discouraged as it often diminishes the learners' ability to attempt an answer because they have not had regular practice in preparing the basic elements of a drawing.

QUESTION 3: ISOMETRIC DRAWING

Isometric drawing is a topic which is introduced in Grade 10. That so many candidates were not to be able to get the basics right is cause for concern. This includes drawing the width and depth axes inclined at 30° to the horizontal, placing the lowest point of the drawing on a designated point indicated on the drawing sheet or orientating the drawing correctly.

It must be noted here that there are different methods of preparing an isometric drawing, all of which are acceptable.

The ability to correctly convert a Grade 12 orthographic drawing into an isometric drawing takes a considerable amount of practice. From the number of candidates who find this question challenging, it is evident that many of the centres in all provinces are not giving learners enough practice tasks and course drawings at an appropriate level.

Common errors and misconceptions

- (a) 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. Accuracy appears to be a common problem, even among the top candidates.
- (b) Many of the weaker candidates had a problem constructing a regular hexagon as discussed previously in Paper 1, Question 2. The auxiliary view, a concept introduced in Grade 10, must be used in certain cases when it is necessary to draw non-isometric lines, and when required, must be visible on the drawing sheet.
- (c) The cut part of the isometric drawing was intended for the top candidates. The weaker candidates would have found this challenging. It must be stressed that the rules of hatching in the *SANS 10111 Code of practice for engineering drawing* applies to any format of drawing. Many candidates appear not to understand that a rib is never hatched. Following on from this is that one of the fundamental rules of hatching is that one cannot hatch through a line. Therefore, the sectioning of the two adjacent surfaces on the cut part of the isometric drawing must be hatched in alternate directions, as one surface lies on a horizontal plane and the other on a vertical plane.

Suggestions for improvement

- (a) Isometric drawings, like many other topics, require practice. The practice is not only in preparing isometric drawings, applying the concept of the auxiliary view and constructing isometric circles, it is also about acquiring the skill to convert a drawing from third-angle orthographic drawing into isometric which takes many learners a long time to acquire.
- (b) Constructing an isometric circle or semi-circle is a Grade 11 concept. The method that must be used is the one that requires the candidate to use a compass to draw the ellipse. Freehand curves are unacceptable and are not marked. Candidates must remember to draw centre lines in circular objects.
- (c) 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 level of complexity that is expected in the grade. It is important that Grade 12 learners engage with the work meaningfully in order to fully prepare themselves for the examination.
- (d) 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.

QUESTION 4: MECHANICAL ASSEMBLY

A mechanical assembly question involves working with graphic and numeric information that has to be understood as well as applying drawing practices contained in the *SANS 10111 Code of practice for engineering drawing*. Many of the weaker candidates become overwhelmed with all this information and the processing of it and often find it challenging. To this end the exploded isometric drawing, showing the position of each part relative to all the others, is included in the parts sheet as an aid to help the candidate visualise the shape of the parts as some parts of the assembly would be unfamiliar to them. It also helps with the sequencing of the assembled parts.

The question was divided into two subsections; a half-sectional front view and a right view. If the candidate did not read the question or understand the concept of the placement of views in third-angle orthographic projection, they may have had a problem with fitting both views onto a drawing sheet.

Common errors and misconceptions

- (a) The method of constructing a hexagonal nut in a mechanical assembly is different from constructing a right hexagon as previously discussed in this paper and Paper 1. The information given requires a candidate to scribe a circle equal in diameter to the *AF* (across the flats) distance thereafter to construct the hexagon as a set of tangents to the circumference of the circle. Constructing of the nut in the assembly was poorly executed.
- (b) There were some unnecessary but general mistakes made by many candidates which need to be addressed at many centres in all the provinces. These include omitting centre lines which should have been copied across from the parts sheet. They also showed little to no understanding of the half section. This was shown by the candidates hatching the entire front view. Candidates confused the simplest of concepts for example between a radius and a diameter.
- (c) To cater for the top candidate a bevel gear was included in the assembly. An example of the *SANS 10111* conventional representation of a bevel gear was added to the parts sheet. It was disappointing to see how few candidates were able to apply this knowledge. This concept has been examined before.
- (d) The exploded isometric drawing, showing the position of each part relative to all the others, should be used both as an aid to help the candidate visualize the general shape of the parts but more so, the sequencing of the parts in the assembly. The generally poor attempt at assembly shows that candidates are not using the isometric drawing for its intended purpose.

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 drawing*, DBE approved textbooks and past NSC exam papers.
- (b) Accuracy has to be mentioned again as it is a fundamental aspect in preparing drawings in the topic, a tolerance of 1 mm is allowed when marking a drawing. Learners must be informed that they will lose marks if they cannot work accurately.
- (c) Course drawings must be set at an appropriate level so that learners can engage meaningfully with work and at the required level.

- (d) The rules of hatching used to differentiate the various parts in a sectional elevation are contained in the SANS 10111 guideline and all approved DBE textbooks. The hatching techniques that must be used in mechanical castings is a Grade 10 concept and the part section where the woodruff key goes into shaft, a Grade 11 concept. Questions need to be asked about why so many candidates had challenges with these basic concepts. Teachers and learners are able to access past NSC papers on the DBE website for reference purposes.
- (e) 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 end of the year examinations.
- (f) All drawings must be prepared using the correct instruments. Any work presented in freehand, even if correct, is not marked.
- (g) Learners should be expected to sit for an examination without being taught time management. This concept can only be realised by setting course drawings with time constraints and getting learners to draw within these time constraints.

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