



basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

REPORT ON THE 2019 NATIONAL SENIOR CERTIFICATE DIAGNOSTIC REPORT

PART 3

Let's grow South Africa together



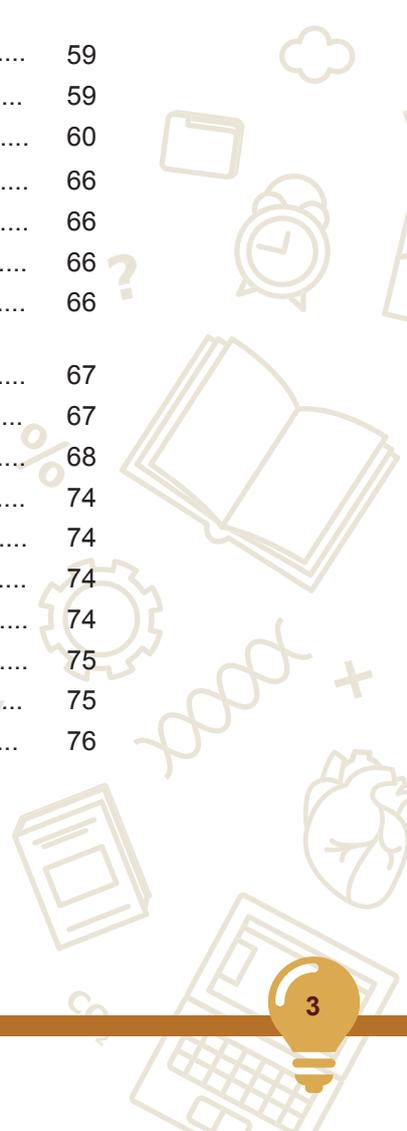


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Foreword from the Minister



The Class of 2019 sat for the National Senior Certificate (NSC) examinations in a year that our great nation celebrated 25 years of democracy, constituted the sixth democratic parliament and South Africans united in celebrating yet another Rugby World Cup victory. In his State of the Nation Address, the President of the Republic of South Africa, the honorable Cyril Matamela Ramaphosa highlighted education as one of the seven priorities of the new administration.

The gradual improvement in the basic education system is affirmed by a 3.1% increase in the NSC pass rate from 78.2% in 2018 to 81.3% in 2019. The cornerstone of the democratic era has been an improving education system committed to the pursuit of quality basic education, the necessary raising of standards and careful introspection of progress. Government's strategy of improving basic education quality has been articulated in the National Development Plan (NDP) Vision 2030: Our future – Make it work.

In this regard, the education sector has listed eleven priorities for this administration, which include *inter alia*, improving the foundational skills of literacy and numeracy; implementation of a curriculum with skills and competencies for a changing world; dealing decisively with the quality and efficiency through the implementation of standardised assessments; urgent implementation of the two-years of Early Childhood Development before Grade 1, promoting school safety, health and social cohesion and completing an integrated Infrastructure Development Plan.

It is against these priorities and noting that the education enterprise is a highly complex activity where the outcome is based on a multiplicity of factors, that we use the National Senior Certificate

examination results, as one of the barometers to evaluate our success. There are noteworthy signs of progress as observed in the recent cycles of international and regional assessment programmes.

In terms of the Action Plan of the Department of Basic Education (DBE), the following three key targets are directly measured through the performance in the National Senior Certificate:

- (a) Increase the number of Grade 12 learners who become eligible for a Bachelor's Programme at a university;
- (b) Increase the number of Grade 12 learners who pass Mathematics; and
- (c) Increase the number of Grade 12 learners who pass Physical Science.

I am pleased to release the 2019 National Diagnostic Report on Learner Performance. This report is in its ninth year of publication and serves as a comprehensive analysis of candidates' performance in the NSC Examinations.

In the State of the Nation Address the President pointed out that there is a need to improve the capabilities of teachers. This Diagnostic Report provides teachers, subject advisors, curriculum planners and social partners with insight into learners' performance in the ten (10) key subjects, English First Additional Language, the twelve (12) official home languages, the Technologies and Technical subjects currently offered in the NSC examinations.

For the third time, the Department of Basic Education (DBE) is offering a detailed analysis of learners' performance in each of the official home languages.



Foreword from the Minister (Continued)



The pivotal purpose of the diagnostic report is to serve as a catalyst to improve the quality of teaching and learning through reflection and remediation at all levels of the system. The data and accompanying analyses prepared, post the writing of the 2019 NSC examinations have been used to identify strengths and weaknesses in candidates' knowledge and skills.

This diagnostic report is presented in three parts. Part 1 comprises the diagnostic reports of the ten key subjects, Part 2 contains the diagnostic reports for English First Additional Language and the twelve home languages and Part 3 includes the diagnostic reports for Technical subjects and Technologies.

In the 2019 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 of learners' responses is given for English First Additional Language and a detailed qualitative analysis of learners' responses to questions is given for each of the home languages.

Analyses conducted shows the weaknesses in learners' responses in the different subjects. An analysis of the misconceptions or error patterns uncovered in the learners' responses can inform instructional practice. In response to weaknesses identified, the report further suggests remedial measures that should be adopted at school level, allowing 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.

Teachers are encouraged to conduct and integrate the diagnostic analysis into their everyday teaching and assessment, so that the performance of learners in classroom-based tests and designated school-based assessment tasks are also analysed and the outcomes utilised to inform remediation.

In conjunction with the National Diagnostic Report on Learner-Performance, the DBE will – through targeted interventions – continue to capacitate teachers to develop responsive and appropriate instructional programmes that will successfully address the areas of weakness identified in this report. I am confident that through this Diagnostic Report and the myriad of other interventions implemented in the system, there will be a positive impact on learner performance in 2020.

MRS AM MOTSHEKGA, MP
MINISTER OF BASIC EDUCATION
08 JANUARY 2020

Chapter 1

1.1. INTRODUCTION, SCOPE AND PURPOSE

The Class of 2019 is the sixth cohort that sat for the NSC examinations based on the CAPS. In line with past reports, the 2019 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, English First Additional Language, the twelve official home languages, the Technologies and Technical subjects. It is essential that the 2019 diagnostic report should be used in conjunction with the 2014 to 2018 diagnostic reports. Key subject didactic principles and content matters addressed in past reports can be used fruitfully in the classroom in 2020.

Post the marking process, the chief markers, internal moderators and subject specialists compile 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 2015 to 2019. 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 2019 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. 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. In essence, progress or lack thereof, in the said areas, should determine the extent to which further interventions are necessary in 2020. 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 2020. 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. Particular 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 (2015 – 2019)

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 2019 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 makes reference to generic areas of good performance or weakness and the possible reasons for these observations.

Section 3: Diagnostic Question Analysis

This includes the following:

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

The internal moderators' reports from all nine provinces for each question paper, per subject were consolidated and the findings are summarised in this report. It is recommended that this report be read in conjunction with the November 2019 NSC question papers since particular 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 2019; develop strategies for differentiated learning and provide a frame of reference for the development and design of school-based assessment during the course of the year.

1.3 LIMITATIONS

The 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 2019 examination papers. While further quantitative data would have been useful in providing feedback for the purpose of test development, this is not the intention of this report.

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 2019 diagnostic reports for the ten key subjects covered in this publication (Part 1), indicate that the pass rate has improved in seven (7) of these subjects (Accounting, Agricultural Sciences, Business Studies, Geography, History, Mathematical Literacy and Physical Sciences) at the 30% levels. The pass rate has however declined to varying degrees at the 30% level in Economics, Mathematics and Life Sciences. The pass rate for English First Additional Language improved at the 30% level and at the 40% level. In the home languages (Part 2) the pass rate has improved at the 40% level in isiNdebele, isiZulu and South African Sign Language; remained the same in two home languages (isiXhosa and Tshivenda) and declined to varying degrees in Seven (7) home languages (Afrikaans, English, Sepedi, Sesotho, Setswana, SiSwati and Xitsonga).

After 6 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 the CAPS, is considered to be stabilising. In most subjects, there was an improvement in the quality of learners' responses in the 2019 NSC examinations. Moreover, it is imperative that we reflect on and learn from the performance of candidates of the 2019 NSC examinations.

The following areas of concern were identified in past diagnostic reports and they are, once again, highlighted as concerns in the 2019 NSC examinations.

- There was a general observation that not all topics were equally covered in preparation for examinations. It is essential that all prescribed topics in the CAPS are studied and that there is adherence to the examination guidelines.
- SASL HL, Technical Sciences, Technical Mathematics and the Technologies were offered for the second 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 new topics.

- In most home languages, the vast majority of 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.
- It was further noted that, in most languages, candidates did not understand the vocabulary used in comprehension texts. In view of this, 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. Vocabulary exercises and reading need to be promoted in schools.
- 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.
- A large percentage of candidates displayed a limited understanding of subject matter, and specifically complicated topics. This 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 2014 to 2019

The diagnostic reports published from 2014 to 2019 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 2020 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. In an effort to build learners' language proficiency and their confidence in decoding both the Language of Learning and Teaching (LoLT) and the language of assessment, teachers are encouraged to add their own language aspects, as these apply within the context of their schools or classrooms. The following points serve as a guide to teachers:

- There needs to be greater emphasis on aspects of language competence and examination technique. Candidates often have the ability to 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

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

- 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.
- Teachers from different schools in a given circuit or district could collaborate to support one another in mediating challenging topics to learners.
- Challenging topics must be revisited regularly during the course of the academic year. Stronger candidates can be paired with weaker candidates to complete assignments on challenging topics.
- Study groups could be formed to facilitate revision activities and examination preparations.
- 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

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.

Subject Advisors and district officials:

- Subject advisers are encouraged to convene meetings/workshops that aim to mediate this diagnostic report. It is further suggested that the use of this diagnostic report must 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 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.

Teachers:

- In order to develop learners' holistic understanding and applied competence, teachers must prepare learners adequately by creating learning opportunities to reflect, analyse and evaluate the content
- Teachers should ensure coverage of the curriculum and the full range of cognitive levels in their teaching and assessment strategies. The mere recall of procedures or specific content on the part of learners will not enable them to respond fully to the demands of the question paper.



Chapter 2

TECHNICAL MATHEMATICS

The following report should be read in conjunction with the Technical Mathematics question papers of the November 2019 examinations.

2.1 PERFORMANCE TRENDS (2018–2019)

In 2019, 9 670 learners sat for the Technical Mathematics examination. The performance of the candidates in 2019 showed an overall decline in comparison to 2018. The performance at 30% and above was 42,7%, representing a decline of 8,0% from 2018. The performance at 40% and above declined by 7% in 2019 to 24,1%.

Table 2.1.1(a) Overall Achievement Rates in Technical Mathematics

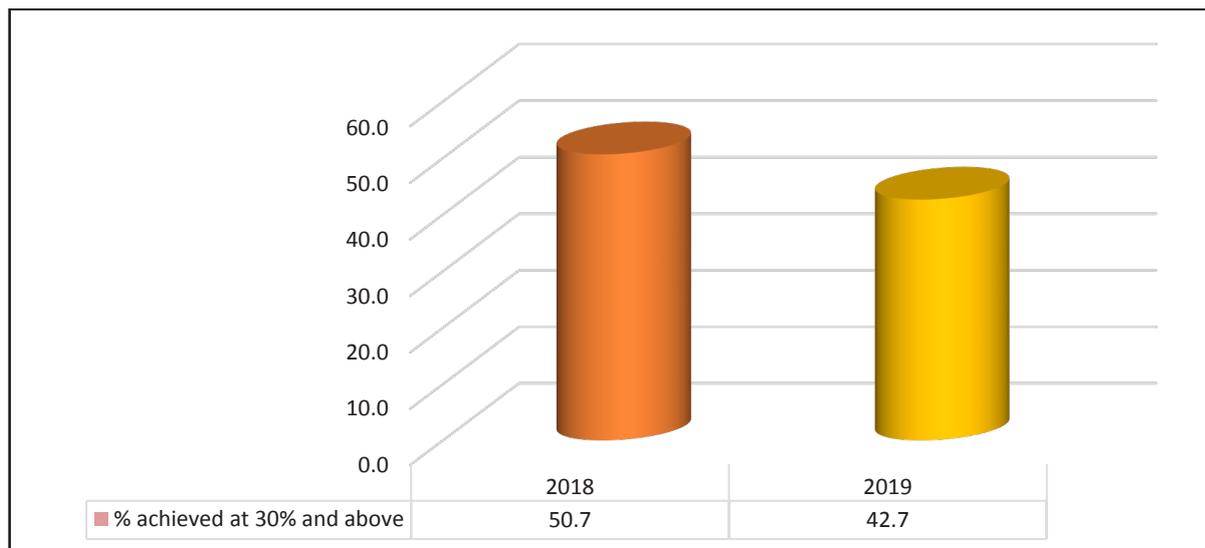
Year	No. wrote	No. achieved at 30% and above	% achieved at 30% and above	No. achieved at 40% and above	% achieved at 40% and above
2018	10 025	5 075	50,7	3 178	31,7
2019	9 670	4 125	42,7	2 330	24,1

The performance of learners in Technical Mathematics in the 2019 examination can be attributed to the subject being new, with many teachers still trying to cope with the demands of the subject.

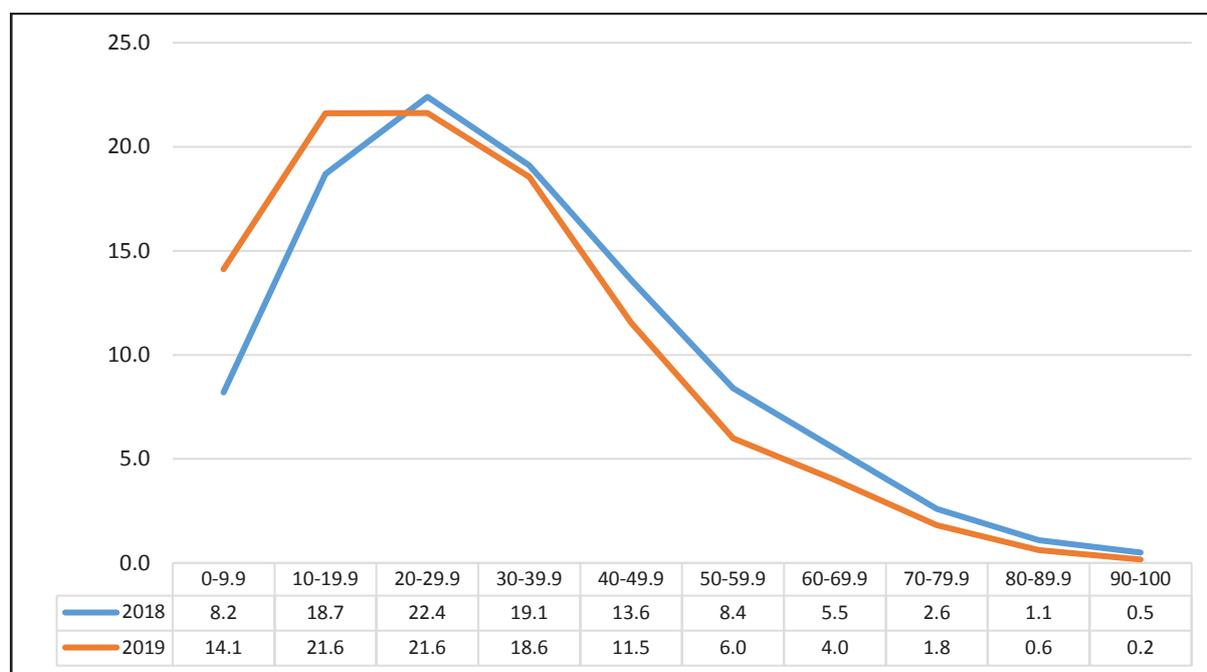
However, there is still room for improvement in the performance of the candidates if the challenges surrounding problem-solving skills, mathematical skills, conceptual understanding and integration of topics as well as technically related (modelling) aspects are addressed.

Revision of work from earlier grades will play an integral part in improving performance in the subject. 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.'

Graph 2.1.1(a) Overall Achievement Rates in Technical Mathematics (Percentage)



Graph 2.1.1(b) Performance Distribution Curve in Technical Mathematics (Percentage)



2.2 OVERVIEW OF LEARNER PERFORMANCE IN PAPER 1

General Comments

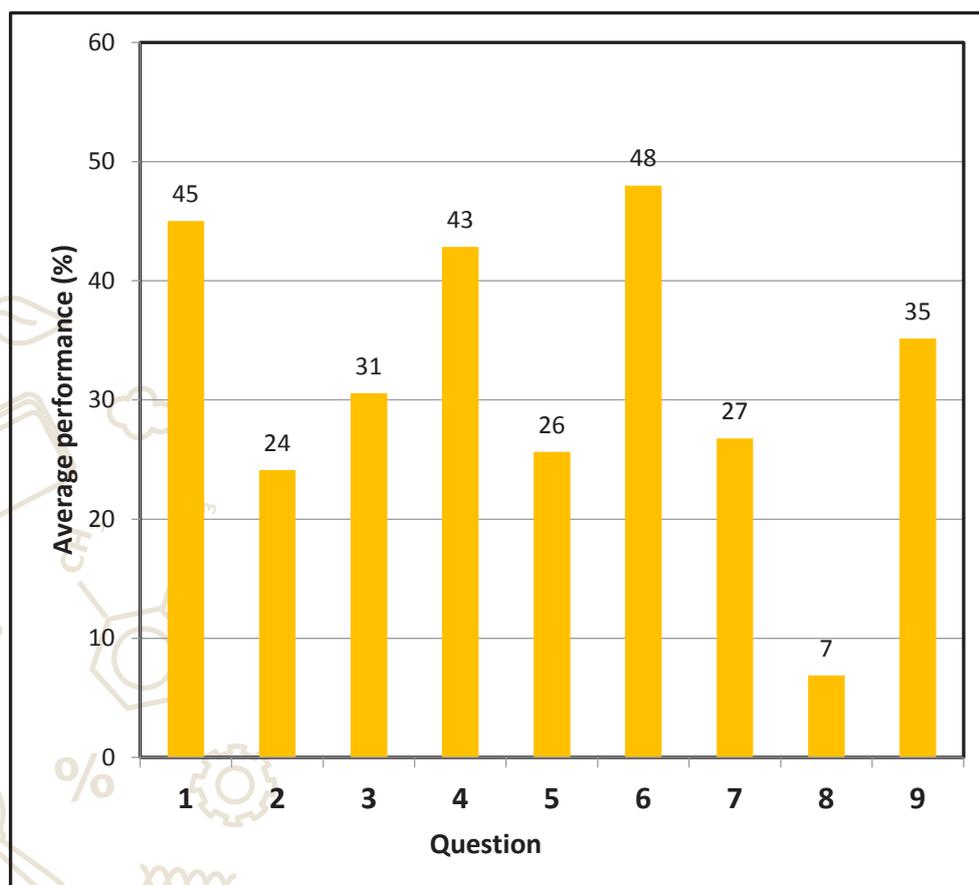
- Candidates performed well in Q1, Q4 and Q6. The topics covered in these questions were Algebra, Functions and Calculus. Candidates performed best in solving simultaneous equations, calculating the derivative using first principles and calculating the intercepts of cubic functions.
- Candidates performed poorly in the following topics: Nature of Roots, Finance, Growth and Decay, Logarithms, Calculus applications involving interpretation of cubic functions and Integration. Candidates performed very poorly in the Application of Calculus involving optimisation.

- (c) 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.
- (d) It was observed that higher-order questions, e.g. interpretation of graphs, were either not answered or poorly answered. Questions in which topics were integrated proved to be beyond the reach of most candidates.
- (e) Candidates did not read and follow the instructions as stipulated in the question paper.

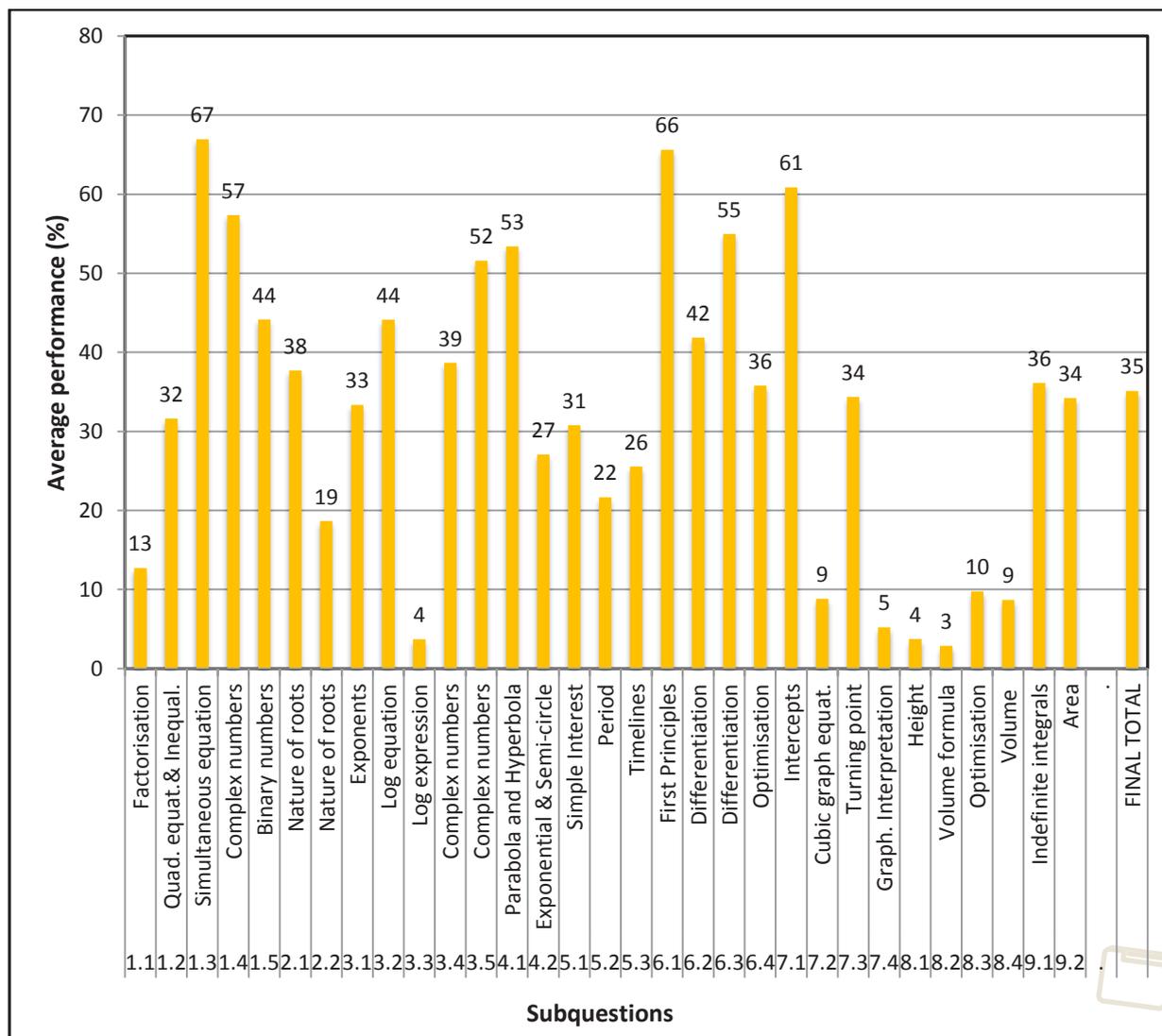
2.3 DIAGNOSTIC QUESTION ANALYSIS OF PAPER 1

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 Percentage Performance per Question for Paper 1



Graph 2.3.2 Average Percentage Performance per Subquestion for Paper 1



2.4 ANALYSIS OF LEARNER PERFORMANCE IN EACH QUESTION IN PAPER 1

QUESTION 1: EQUATIONS AND INEQUALITIES (ALGEBRA)

Common Errors and Misconceptions

- In Q1.1.1 candidates did not realise that they had to remove a common factor and then factorise the difference of two squares.
- Many candidates failed to write the negative root in Q1.1.2.
- In Q1.2.1 many candidates could not determine the correct product. This led to an incorrect standard form. Some candidates equated each factor to -13 . Other candidates were unable to write the $\sqrt{-35}$

as a complex number. They left the roots of the equation as $x = \frac{-1 \pm \sqrt{-35}}{6}$.

- (d) When answering Q1.2.2, most candidates did not realise that $(4 - x)$ is not the same as $(x - 4)$. Therefore, they did not change the inequality and lost a mark for the incorrect critical value and incorrect notation.
- (e) In Q1.3 candidates were unable to square a binomial, simplify correctly and then determine the correct standard form. Some candidates complicated the equation by making x the subject.
- (f) A few candidates divided by V instead of Z when making I the subject of the formula.
- (g) Many candidates did not realise that they needed to multiply by the conjugate in Q1.4.2.
- (h) In Q1.5 most candidates omitted the base 2.

Suggestions for Improvement

- (a) Solution of simultaneous equations, on a regular basis. These skills are required to answer Grade 12 examination papers. Manipulation skills should be reinforced.
- (b) Teachers need to emphasise that if an equation is already given in factor form and equated to zero, then learners need to write down only the required roots of the equation.
- (c) Teachers should point out the difference between an equation that is already factorised and equated to zero, e.g. $(3x - 5)(x + 2) = 0$ and one that is factorised and not equal to zero, e.g. $(3x - 5)(x + 2) = -13$.
- (d) Teachers should be aware that the integration of topics is possible. When teaching solution of the quadratic equations, teachers should expose learners to the fact that non-real roots in the real number system can be written as complex numbers in the complex number system.
- (e) Before teaching quadratic inequalities, teachers should first revise linear inequalities and their graphical representations. In teaching inequalities, teachers should integrate Algebra with Functions so that learners have a visual understanding of inequalities. Furthermore, emphasise the correct use and interpretation of *or* and *and*. It should be stressed that multiplying or dividing by a negative number reverses the inequality sign. Demonstrate different methods to solve inequality problems so that learners may choose the method that they understand best.
- (f) Technical Mathematics learners should be exposed to different forms of real-life technical problems.
- (g) Teachers need to explain the process of rationalising the denominator in which the fraction contains a complex number in the denominator. Teachers should demonstrate, side by side, the results when a complex number is multiplied by itself versus when the same number is multiplied by its conjugate. This will explain why multiplying the denominator by the conjugate is necessary.

- (h) Revision of operations involving binary numbers and the conversion from one number system to another should be done in Grade 12. Teachers should emphasise the importance of writing numbers in 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 becomes rather cumbersome to write the base 10 each time we write a decimal number. It is for this reason that the base is omitted from decimal numbers. If there is no base indicated for a number, it is taken that it is a decimal number.

QUESTION 2: NATURE OF ROOTS

Common Errors and Misconceptions

- (a) Many candidates assumed a value for p and substituted the same in their calculations. They did not understand the meaning of 'undefined' and 'zero' in Q2.1.1 and Q2.1.2, respectively.
- (b) In Q2.2 candidates failed to write the correct standard form and consequently they were unable to identify the values of a , b and c . Many candidates failed to state the conditions for the discriminant for the given nature of roots.

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. Teachers need to explain that *undefined* and *zero* are very different concepts. Furthermore, teachers need to explain that literal fractions are *undefined* when the denominator is equal to zero and that these fractions are equal to *zero* when the numerator is equal to zero.

- (b) Teachers need to expose learners to application questions involving the nature of roots. These should include solving problems where the conditions are given.

QUESTION 3: EXPONENTS, SURDS, LOGARITHMS AND COMPLEX NUMBERS

Common Errors and Misconceptions

- (a) In Q3.1 many candidates could not apply the laws of exponents and convert from surd form to exponential form.
- (b) Some candidates were unable to apply the laws of logarithms in Q3.2 and Q3.3. They also had difficulty with converting a decimal fraction to a proper fraction.

- (c) In Q3.4.1 many candidates did not follow the instruction 'write the equation in rectangular form' but wrote it in C/S form instead. Several candidates omitted the value of r in the calculations.
- (d) Most of the candidates used a calculator in Q3.4.2. They ignored the instruction that that stated that the answer should be in 'simplified surd form'.
- (e) In Q3.5 many candidates did not write the value of m and n as required; instead they left the equation at the simplification step.

Suggestions for Improvement

- (a) Learners should revise all exponential laws, the definition and all the laws of logarithms done in Grade 11.
- (b) Teachers need to strengthen the concept of prime factors and reinforce the method of converting decimal fractions to proper fractions.
- (c) Teachers should emphasise that learners must adhere to the given instructions, particularly instructions that pertain to the use of calculators. They should be reminded that if they fail to adhere to this instruction then they stand to lose marks. Teachers are advised to penalise learners in informal and formal assessment tasks should they choose to ignore instructions that are clearly indicated.

QUESTION 4: FUNCTIONS

Common Errors and Misconceptions

- (a) In Q4.1.2 some candidates wrote down the equation of the asymptote instead of the x -intercepts.
- (b) Many candidates could not determine the product correctly. They were unable to arrive at the correct standard form and hence the coordinates of the turning point were incorrect in Q4.1.3.
- (c) In Q4.1.4 candidates wrote the equations of the asymptotes in terms of p and q instead of writing them as equations in terms of x and y respectively.
- (d) In Q4.1.5 many candidates used an incorrect scale for their graphs and could not identify the shapes of the required graphs.
- (e) Some candidates did not recognise that d was an asymptote of h .
- (f) Candidates did not know how to respond to a question in which the instruction read: 'Show that ...'
- (g) In Q4.2.3 candidates could not simplify the exponential function in which the index is 0.
- (h) Candidates could not differentiate between the *range* and the *domain*. They often used an incorrect notation in the answer. They would give the range as a set of elements in x and the domain as a set of elements in y .

- (i) Candidates could not write down the equation of the reflected graph.
- (j) Interpretation of graphs posed a challenge for many candidates. They did not understand what was required of them when given that a function is less than the other. Most of the candidates used incorrect notations in their answers.

Suggestions for Improvement

- (a) Teachers should emphasise the difference between the *intercepts* and the *asymptotes* of graphs. They should also explain that, in most cases, the asymptotes are horizontal and vertical lines. Therefore, the equation of the vertical asymptote should be given as $x = \dots$ and the equation of the horizontal asymptote should be given as $y = \dots$
- (b) Definition and correct notation of domain and range should be thoroughly explained and demonstrated to learners.
- (c) Teachers should expose learners to different ways of finding the coordinates of the turning point of the parabola.
- (d) Learners need to be advised to use the table method when sketching graphs and to connect all the points as in the table. Shapes and characteristics of graphs should be thoroughly explained and demonstrated to learners.
- (e) Learners need to be taught that when the question states '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.
- (f) Teachers should incorporate transformations when teaching functions and graphs.
- (g) More time must be spent on the meaning of inequalities and what they represent. This includes the emphasis on interval notation and the use of inequality signs to represent the same interval.
- (h) Teachers should demonstrate the idea of where one graph is less than the other graph and show learners, in a systematic way, how the interval for which one graph is less than the other is read off the x -axis.
- (i) Teachers should expose learners to questions involving two graphs on one system of axes, incorporating interpretation questions.

QUESTION 5: FINANCE, GROWTH AND DECAY

Common Errors and Misconceptions

- (a) In Q5.1.1 many candidates could not read the correct value from the graph.
- (b) In Q5.2.2 some candidates could not identify the correct formula. Some candidates swapped the values of A and P in the formula and many could not make i the subject of the formula.
- (c) In Q5.2 many candidates could not identify the correct formula or substituted incorrect values in the formula. Some candidates could not write the equation in logarithmic form. Other candidates calculated the period but were unable to make a conclusion.
- (d) When answering Q8.3, many candidates could not set up a timeline showing the different compounding periods within the given 8-year period.

Suggestions for Improvement

- (a) Teachers should demonstrate how to read off graphs and how to interpret graphs to obtain the required responses.
- (b) Teachers need to indicate that in all formulae P represents the initial amount. In the case of depreciation, P represents the initial cost and in the case of growth, P represents the amount initially invested or the original number. In all formulae, A represents the final value of P after some time has elapsed.
- (c) Depreciation is a reduction scenario, i.e. an item loses value after it is bought. This implies that the cost price (P) will always be greater than the book value (A). Therefore, teachers need to emphasise that in scenarios that involve depreciation, the value of P will be greater than the value of A . In contrast, growth is an increasing scenario therefore the value of P will be less than the value of A .
- (d) Teachers need to show 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.
- (e) Teachers should first revise the conversion of an exponential equation to a logarithmic equation before learners are taught to calculate the value of n .
- (f) Teachers should teach all compounding periods (annually, quarterly, monthly, semi-annually/half-yearly and even daily). It is advisable to use timelines in order to better understand a complex problem involving several investments and withdrawals.
- (g) A good understanding of Financial Mathematics is best developed through practice. It is important to expose learners to different kinds of questions so that they identify the appropriate formula relevant to the scenario.

QUESTION 6: CALCULUS

Common Errors and Misconceptions

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

- Used the 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 $f(x) = \lim_{h \rightarrow 0} \frac{f(x+h) - f(x)}{h}$.
- Could not substitute correctly in the formula.
- Omitted brackets when substituting $f(x)$.

(b) In Q6.2.1 candidates failed to realise that a^3 was a constant and went on to differentiate a^3 as $3a$.

(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 were unable to determine the product. Some candidates further simplified the expression containing unlike terms in Q6.3.1. They did not realise that unlike terms cannot be added or subtracted. Candidates failed to apply the exponential laws correctly in cases where they multiplied or divided terms involving x .

(d) Generally, candidates were unable to write the correct differentiation notation or simplify the expression to be differentiated. A few candidates integrated the expression given in Q6.3.2 instead of differentiating it.

(e) In Q6.4.2 many candidates misinterpreted the 'zero daily profit'. They substituted 0 in the expression instead of equating the expression to 0.

(f) Many candidates did not realise that they had to differentiate first to find the rate of change. They substituted 200 in $p(x)$ instead of $p'(x)$.

Suggestions for Improvement

(a) Teachers should emphasise that when determining the derivative using first principles, the notation

$\lim_{h \rightarrow 0}$ must be written down and should only be left out when writing the final answer, i.e. once the learner has substituted that value of h . The continued practise of simplification of expressions and algebraic fractions is encouraged.

- (b) Teachers should explain to learners that the notation $f'(x)$ means that one is required to differentiate the expression f with respect to x . Teachers should draw attention to the various notations used to indicate that the derivative of an expression is required. That is, determine: $f'(x)$ 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.
- (c) Differentiation involves working with the exponent. It is therefore advisable that teachers revise the laws of exponents and the application thereof prior to teaching the rules for differentiation.
- (d) Teachers should define a derivative in relation to gradient at a point on a curve, gradient of a tangent, rate of change and calculus of motion. If well explained, then learners will understand that whenever they see a question related to rate of change, they need to calculate the derivative first. When required to calculate the rate of change for an instant, learners need to be aware that they need to substitute the given value in the derivative function and not the original function.

QUESTION 7: CUBIC FUNCTION

Common Errors and Misconceptions

- (a) In Q7.1 candidates did not use the given straight line to calculate the coordinates, as required in the question.
- (b) Candidates did not understand how to respond to this question. In Q7.2 most candidates used the function as if it was giving information instead of proving that the function was as given.
- (c) In Q7.3 some candidates used the derivative function to calculate the value of x . However, they then re-substituted these values of x in the derivative function instead of substituting in the original function when determining the y -coordinates. Some candidates did not equate the derivative to zero. A few candidates managed to get the two correct x -coordinates of the turning points but failed to identify the correct one for R and therefore were unable to calculate the y -coordinate of R. Many of the candidates used the quadratic method of finding the turning point. This is not applicable to cubic functions.
- (d) Many candidates did not understand the concept of a tangent to a curve at a point in Q7.4.1.
- (e) In Q7.4.2 and Q7.4.3 candidates struggled with the interpretation of graphs. Most candidates could not identify the correct interval where the graph is above the x -axis, and as a result the notation and critical values were incorrect. They also could not identify the correct interval where the derivative function is decreasing, and as a result the notation and critical values were incorrect. Some candidates who identified the correct interval where the derivative function was decreasing, failed to write the interval using the correct notation.

Suggestions for Improvement

- (a) Learners must be taught how to relate the given information to the questions asked.
- (b) Learners need to be taught that when a question asks to 'show that ...', it means to calculate (justify by means of mathematically correct steps) what is given, and the answer must be as required. Teachers should expose learners to a variety of examples where they are required to 'show' or 'prove' something.
- (c) Teachers need to emphasise that the derivative is equal to zero at the turning points. Teachers should indicate to learners that $x = -\frac{b}{2a}$ applies only to quadratic functions and not to cubic functions.
- (d) Teachers should explain that the gradient of a tangent is the derivative of a function at the given point. Learners should be exposed to higher-order thinking questions and interpretation of graphs. Initially teachers should assist learners to understand what is being asked, what it looks like in the picture and which x-values are relevant to the interval of the required solution.
- (e) Teachers should explain the concepts of maxima and minima and demonstrate to learners where the graph is increasing, turning or decreasing with the aid of diagrams. Software, like Geometry Sketch Pad, Graph and GeoGebra, can be useful to demonstrate the above.

QUESTION 8: APPLICATION OF CALCULUS

Common Errors and Misconceptions

- (a) Many candidates could not set up the expression for the height of the container in Q8.1.
- (b) In Q8.1.2 many candidates could not determine the expression for the volume of the container.
- (c) Most candidates did not realise that the word 'hence' in Q8.3 meant that they needed to use the information given in Q8.2. Some candidates did not use the derivative to calculate the value of x. Other candidates did not equate the derivative to 0.
- (d) In Q8.4 many candidates substituted the values of x in the derivative function instead of the function that represented the volume of the container. Some candidates substituted $x = 0$ to calculate the maximum volume.

Suggestions for Improvement

- (a) Teachers should expose learners to different problem-solving techniques. Teachers need to teach learners that using brackets is important when substituting a value in an expression containing more than one term. This is essential when multiplication is yet to be done.
- (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. Learners need to be taught the formulae of different shapes.

- (c) Teachers must explain to learners that the word 'hence' means to use the information obtained in the previous question to solve the question at hand. For optimisation problems, teachers need to emphasise to learners that the first step is to differentiate, equate the derivative to 0 and then factorise or use a formula to find the value of x .
- (d) Learners should be made aware that to calculate the maximum total volume, one needs to substitute the value of x obtained from equating the derivative function to zero, in the expression for the volume.

QUESTION 9: INTEGRATION

Common Errors and Misconceptions

- (a) Some candidates omitted C on indefinite integrals calculations in Q9.1.1 and 9.1.2. After integrating, they still wrote down the integral notation. Generally, many candidates wrote notations incorrectly in Q9.
- (b) Some candidates could not simplify the given expression correctly in Q 9.1.2.
- (c) In Q9.2 candidates swapped the lower and upper limits of definite integrals and did not consider the signs. Some candidates substituted the boundaries in the given function without first integrating.

Suggestions for Improvement

- (a) Teachers should explain that when determining indefinite integrals, C must always be added. Further, the correct use of notation should be emphasised.
- (b) Simplification of expressions covered in previous grades should be revised.
- (c) Teachers should indicate to learners that in definite integrals, the upper limit is always greater than the lower limit. Learners should be made aware that they need to subtract the expression of the lower limit from the expression of the upper limit. Since these expressions may involve more than one term, they need to be careful with the signs. To prevent writing incorrect signs, it is advisable that learners keep the two expressions that are to be subtracted, in brackets.

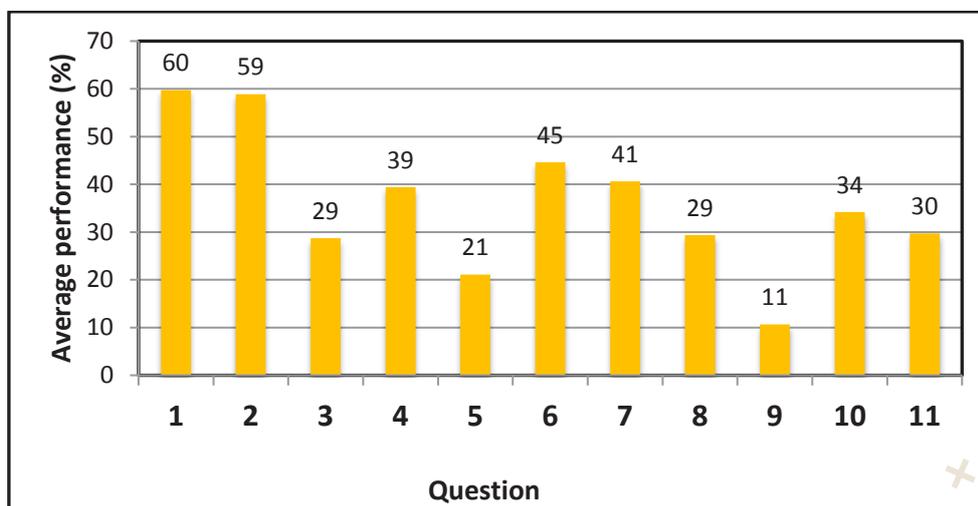
2.5 ANALYSIS OF LEARNER PERFORMANCE IN EACH QUESTION IN PAPER 2

- (a) Candidates performed relatively well in Q1 and Q2. These questions were based on Analytical Geometry. Candidates performed extremely well in questions involving length and midpoint. These concepts were covered in Grades 10 and 11.
- (b) Candidates performed fairly well in Q6 and Q7. These questions were based on trigonometric 2D figures.
- (c) Candidates performed poorly in Q3, Q4, Q5, Q8, Q10, Q11 with Q9 being the worst answered question. These questions largely assessed work covered in Grade 12.
- (d) Candidates did not adhere to the instructions stipulated in the question paper.
- (e) Many candidates did not attempt the higher-order questions.

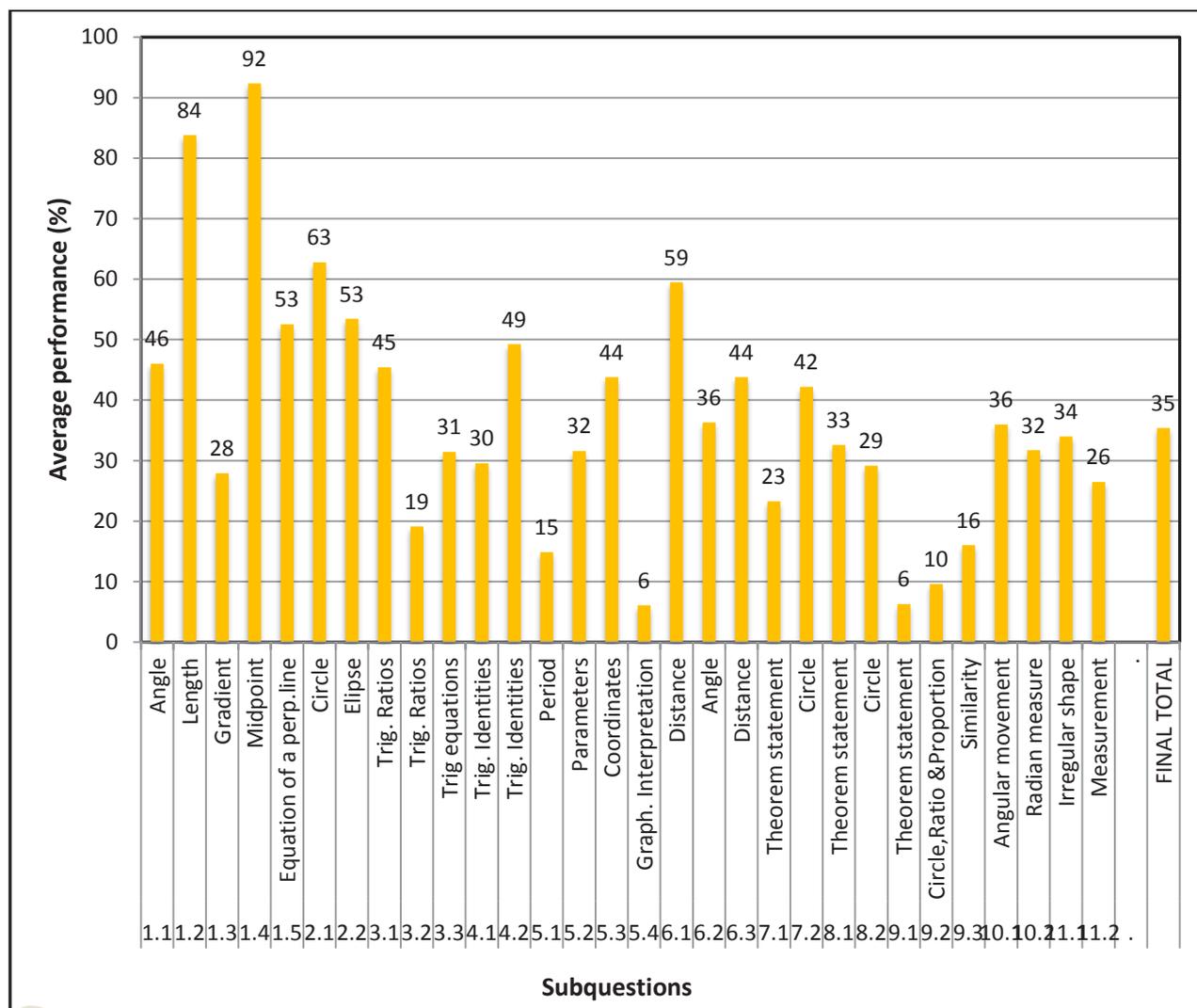
2.6 DIAGNOSTIC QUESTION ANALYSIS FOR PAPER 2

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 Percentage Performance per Question for Paper 2



Graph 2.6.2 Average Percentage Performance per Subquestion for Paper 2



2.7 ANALYSIS OF LEARNER PERFORMANCE IN EACH QUESTION IN PAPER 2

QUESTION 1: ANALYTICAL GEOMETRY

Common Errors and Misconceptions

- When answering Q1.1, candidates failed to take into account that FD was parallel to the x-axis. They also did not realise that the question integrated Euclidean geometry and assumed that $\alpha = 76^\circ$ instead of $180^\circ - 76^\circ = 104^\circ$.
- When answering Q1.2, some candidates made incorrect substitutions in the distance formula and some did not follow the instruction to write their answer in simplified surd form.

- (c) In Q1.3 candidates calculated the gradient by using the formula $m = \frac{y_2 - y_1}{x_2 - x_1}$ even though the coordinates of both points were not known.
- (d) Some candidates, when answering Q1.4, made incorrect substitutions in the correct midpoint formula. Substitution of negative values was a challenge.
- (e) In attempting to determine the equation of the perpendicular line, some candidates used the gradient of AF and not that of the perpendicular. Also, some candidates used the coordinates of A instead of the coordinates of the midpoint, even though A was not a point on the perpendicular line.

Suggestions for Improvement

- (a) Learners should be taught to always read questions before answering. For each question they should establish what is required, what information is given and what information needs to be calculated.
- (b) Teachers should emphasize the minimum requirements for the use of a certain formula. In this regard, attention should be paid as to which formula should be used to calculate the gradient of a straight line when two points on the straight line are given and which should be used when given the inclination of the line.
- (c) Teachers should emphasize the use of brackets when substituting negative values. This will reduce confusion between the negative sign in a formula and the negative sign of the coordinate.
- (d) Learners should be made aware of certain terminology. For example, when dealing with a perpendicular bisector, learners should know that the perpendicular bisector passes through the midpoint of another line segment and is perpendicular to that line segment. Learners need to be reminded that the product of the gradients of two lines that are perpendicular to each other is -1 , i.e. $m_{line} \times m_{perp} = -1$.

QUESTION 2: ANALYTICAL GEOMETRY

Common Errors and Misconceptions

- (a) Most candidates were able to calculate the value of r but they did not substitute it in the equation of the circle.
- (b) Some candidates were unable to use transformation to determine the coordinates of B. Some candidates did not realise that the two tangents are parallel and hence could not use the fact that the gradient of MN = the gradient of PQ.
- (c) In Q 2.1.3 most candidates could not combine the condition for parallel lines and the fact that the tangent is perpendicular to the diameter.
- (d) In Q 2.2.2 some candidates were unable to determine the minor and major axes and hence they drew a graph that was not related to the equation.

Suggestions for Improvement

- (a) Learners should be taught that if they are required to determine the equation of a function or relation, they should calculate the values of the unknowns (parameters). However, learners must then substitute these calculated values in the standard form of the equation of the function.
- (b) Teachers should teach transformations that are implied by prescribed content, e.g. reflection of a point on a circle having the origin as centre.
- (c) Teachers should always integrate different topics in their teaching. Concepts from Euclidean Geometry cannot be ignored when teaching Analytical Geometry.
- (d) Teachers should teach learners the standard form of the ellipse and different ways to express the equation. Determining the major and minor axes is also important when drawing the correct shape of an ellipse.

QUESTION 3: TRIGONOMETRY

Common Errors and Misconceptions

- (a) In Q3.1.1 some candidates calculated $(\sin 3^\circ) \times (32)$ instead of $\sin(3 \times 32^\circ)$. This arose from the incorrect use of brackets when candidates entered the information into the calculator. Some made these calculations while their calculators were set in Radians mode. They obtained incorrect answers.
- (b) Most candidates were unable to manipulate inverse trigonometric ratios. They were unable to use their calculators to determine the numerical value of $\frac{\sec^2 \theta - 1}{\tan \alpha}$.
- (c) In Q3.2.1 candidates used calculators to evaluate $\sin 35^\circ$, against the instruction given. This answer was not awarded any marks as it was not in terms of m .
- (d) In Q3.2.2 some candidates calculated the numerical value of $\left(\cos \frac{29}{36} \pi\right) \left(\tan \frac{7}{36} \pi\right)$ with their calculators in Degrees mode instead of Radians mode.
- (e) In Q3.3.1 many candidates transposed the 2 and incorrectly wrote the statement as $\cos \theta + \sin \theta = -2$. Some candidates just wrote down what they were expected to show.
- (f) Most candidates were unable to determine the reference angle. Some wrote the reference angle as $-63,43^\circ$ and not as a positive angle in the 1st quadrant. Some did not consider the quadrant where the tangent ratio is negative.

Suggestions for Improvement

- (a) Learners should be taught how to use a calculator and to always check the mode before making calculations. The mode selected on the calculator and angle units should be the same.
- (b) Teachers should revise the inverse trigonometric ratios covered in Grade 10 and how to manipulate them so that learners are able to use a calculator to calculate the value of an expression.
- (c) Teachers should emphasise the importance of following the instructions in a question to learners.
- (d) Teachers should expose learners to applications of Pythagoras' theorem in which variables are used.
- (e) Learners must be taught how to convert angle measures from degrees to radians and from radians to degrees.
- (f) Learners should be taught that the reference angle is always in the 1st quadrant, i.e. it is always a positive acute angle. They should be taught the quadrants where specific trigonometric ratios are positive or negative.

QUESTION 4: TRIGONOMETRY

Common Errors and Misconceptions

- (a) In Q 4.1.1 some candidates wrote the answer as 1 instead of -1 .
- (b) Simplification of trigonometric expressions using identities proved to be a challenge in Q4.1.2.
- (c) Candidates were unable to use a calculator to calculate $\sec 60^\circ$.
- (d) In Q4.2.2 candidates were unable to establish the correct quadrant for the given trigonometric ratio. This resulted in them writing the incorrect sign when they did the reductions.

Suggestions for Improvement

- (a) A good understanding of Trigonometry is dependent on learners having knowledge of reduction formulae and fundamental identities. If learners are unsure about the identities, then they must refer to the formula sheet.
- (b) Proficiency in answering questions that involve reductions and identities increase through practice. Teachers should expose learners to a variety of problems that involve identities.
- (c) Teachers should revise inverse trigonometric ratios done in Grade 10 and ways of manipulating them to calculate their numerical value using a calculator. Learners should be given more work that requires calculations of numerical values of inverse trigonometric ratios.
- (d) Teachers should emphasise to learners in which quadrants the specific ratios are positive or negative.

QUESTION 5: TRIGONOMETRIC FUNCTIONS

Common Errors and Misconceptions

- (a) Candidates were unable to differentiate between the concepts of 'period' and 'domain'.
- (b) Candidates were unable to calculate the value of b because they could not relate the period of the graph to the value of b .
- (c) In Q5.3 most candidates added $21,5^\circ$ to 135° instead of subtracting it from 180° .
- (d) Candidates were unable to interpret graphs.

Suggestions for Improvement

- (a) The teaching of trigonometric functions extends beyond the sketching of graphs. Teachers should also explain the characteristics of each basic trigonometric function and how these characteristics change when the basic graph is transformed.
- (b) The purpose of reduction formulae must be explained. It is important to relate reduction formulae to the CAST diagram. Once learners begin to understand how to reduce trigonometric ratios with larger angles and trigonometric ratios with an acute angle, they are more likely to get the reduction correct. As a starting point, learners should be able to identify the quadrant in which the original angle lies.
- (c) 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) Many candidates were unable to make AC the subject of the formula in Q 6.1.
- (b) Some candidates were not able to apply the area rule and they were unable to make β the subject of the formula.
- (c) In Q6.3 candidates made incorrect substitutions in the cosine formula.

Suggestions for Improvement

- (a) Revision should be done of the sine rule, cosine rule and area rule with many examples that involve changing subject of the formula.
- (b) A structured approach to teaching 3-D problems should be adopted. Firstly, learners need to identify the triangles in the sketch. Then they need to establish what information is given about each triangle. Lastly, they need to relate the question to one of the triangles in the sketch. If the triangle has sufficient information to respond to the question, then the solution is a direct one. If there is insufficient information in the triangle, learners may have to look at the other triangles for clues to calculate the missing side(s) and/or angle(s). A good knowledge of the minimum requirements for the application of the sine, cosine and area formulae will make this task easier.
- (c) Both two- and three-dimensional figures must be tested through informal and formal assessment tasks.

QUESTION 7: EUCLIDEAN GEOMETRY

Common Errors and Misconceptions

- (a) Candidates could not recall the statement of the theorem in Q7.1.
- (b) Candidates wrote incorrect reasons or incomplete reasons for the correct magnitude of angles.
- (c) Candidates struggled to work with the variable in Q7.2.2, i.e. the length x .

Suggestions for Improvement

- (a) During the teaching of Euclidean geometry, teachers should regularly give learners activities on the stating of theorems.
- (b) The 'accepted reasons' as stated in the *Examination Guidelines* must be consolidated and reinforced when teaching Euclidean geometry. Teachers should cover the basic work thoroughly. An explanation of the theorem should be accompanied by showing the relationship in a diagram.
- (c) Learners should also be exposed to calculating the lengths of the sides, not only the sizes of angles.

QUESTION 8: EUCLIDEAN GEOMETRY

Common Errors and Misconceptions

- (a) Candidates struggled with the application of circle geometry theorems.
- (b) There was often confusion as to when the theorem could be used as a reason and when the converse would apply.

Suggestions for Improvement

- (a) Teachers should expose candidates to questions that require different ways of applying circle geometry theorems.
- (b) Teachers should explain the difference between a theorem and its converse. Application of converse theorems should be known and practised in solving riders from lower grades.
- (c) Learners should be exposed to questions that have a mixture of theorems, i.e. questions should include knowledge of angles in circles, cyclic quadrilaterals and tangents to the circle.

QUESTION 9: EUCLIDEAN GEOMETRY

Common Errors and Misconceptions

- (a) Some candidates were unable to apply the tangent theorems in Q9.2.1.
- (b) Some candidates struggled to apply similarity theorems. In Q9.2.2 most candidates assumed that E is the midpoint OG.

Suggestions for Improvement

- (a) Teachers should expose candidates to different ways of applying circle geometry theorems.
- (b) Learners should be exposed to questions that assess the integration of circle theorems and similarity theorems.

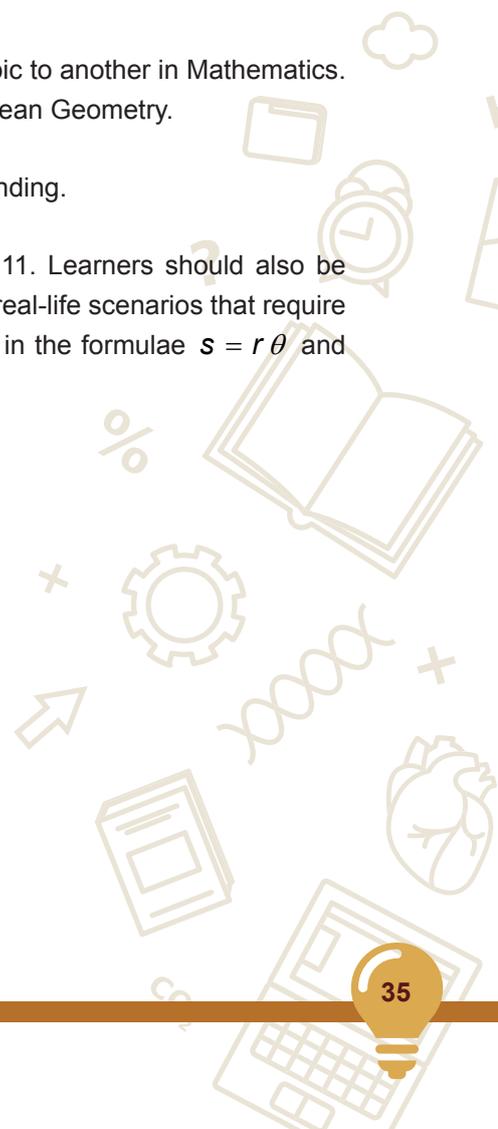
QUESTION 10: CIRCLES, ANGLES AND ANGULAR MOVEMENT

Common Errors and Misconceptions

- (a) Some candidates did not realise that $BC = OC - OB = 20 - 1,5 = 18,5$ cm.
- (b) Some candidates were able to make the correct substitution in the application of Pythagoras' theorem but failed to factorise the resulting quadratic equation in Q10.1.2. Many candidates failed to recall that in order to use Pythagoras' theorem, two sides of the right-angled triangle must be known.
- (c) In Q10.2.1 candidates struggled to determine the size of \widehat{AOB} in degrees. Conversion from degrees to radians was also a challenge for some candidates.
- (d) Some candidates used the correct formula $s = r\theta$ but used the angle measured in degrees instead of radians.
- (e) In Q10.2.2 many candidates wrote the correct formula
$$\text{Area of a sector} = \frac{rs}{2} = \frac{r^2\theta}{2}$$
 but substituted incorrectly. Once again, they used the angle in degrees instead of IN radians.

Suggestions for Improvement

- (a) Teachers should inform learners that skills are transferable from one topic to another in Mathematics. Certain algebraic skills may well be required in Trigonometry and Euclidean Geometry.
- (b) Learners should be advised to read the given information with understanding.
- (c) Teachers need to revise the calculation of arc length done in Grade 11. Learners should also be exposed to problem-solving strategies so that they will be able to solve real-life scenarios that require application of formulae. It should be emphasised that the angles used in the formulae $s = r\theta$ and
$$\text{Area of a sector} = \frac{rs}{2} = \frac{r^2\theta}{2}$$
 should be in radians.



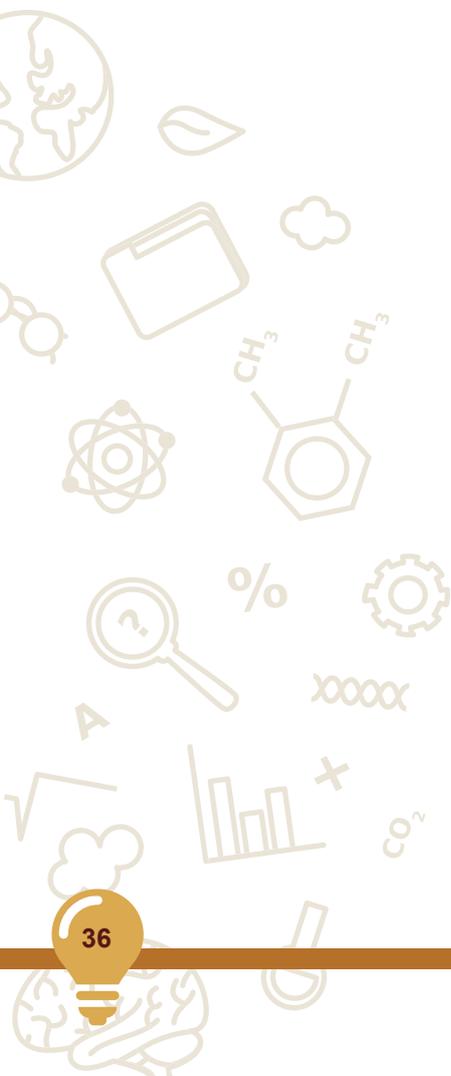
QUESTION 11: MENSURATION

Common Errors and Misconceptions

- (a) In Q11.1.1 some candidates did not read the instruction and left the answer as $\sqrt{2}$.
- (b) In Q11.1.2 many candidates did not use two thirds and most did not make the correct substitution in the formula.
- (c) Many candidates used the formulae given and did not use the volume given.
- (d) Some candidates wrote the diameter and did not realise that they must divide by 2.
- (e) Many candidates did not adapt the formulae for surface areas and hence they got incorrect values.

Suggestions for Improvement

- (a) Teachers need to allow learners to use the formula sheet in informal and formal assessments in Grade 12.
- (b) Mensuration should be thoroughly revised and assessed from lower grades. Learners should know how to adapt a formula in relation to a given situation.



Chapter 3

TECHNICAL SCIENCES

The following report should be read in conjunction with the Technical Sciences question papers of the NSC November 2019 examinations.

3.1 PERFORMANCE TRENDS (2018–2019)

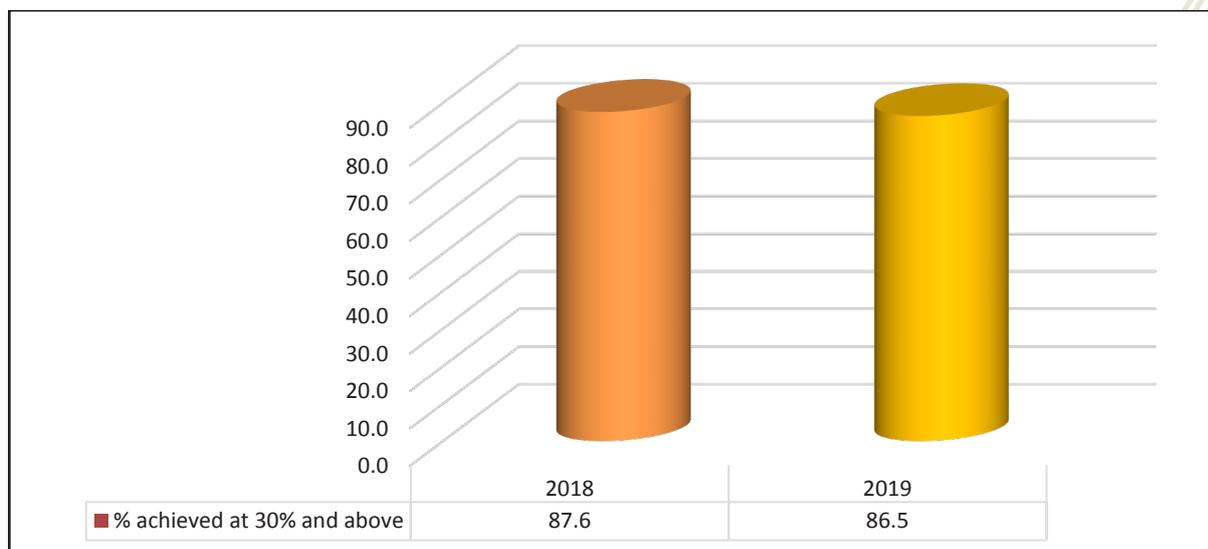
In 2019, 10 862 candidates sat for the Technical Sciences examination. The performance of the candidates in 2019 at the 30% level was 86,5% and at the 40% level it was 48,9%. This shows a slight decline when compared to the 2018 performance.

Table 3.1.1(a) Overall Achievement Rates in Technical Sciences

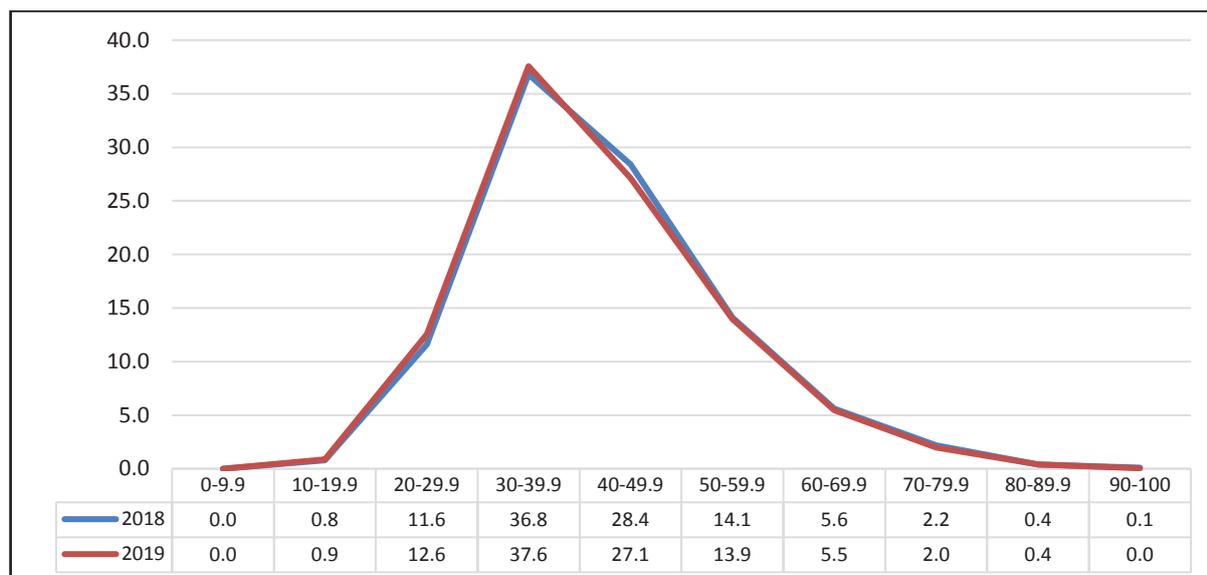
Year	No. Wrote	No. achieved at 30% and above	% achieved at 30% and above	No. achieved at 40% and above	% achieved at 40% and above
2018	10 503	9 204	87,6	5 335	50,8
2019	10 862	9 401	86,5	5 312	48,9

The performance of candidates in Technical Sciences in 2019 was good and can be attributed, in part, to the inclusion of the PAT. There is much room for improvement in the performance of the candidates as the challenges surrounding practical work, problem-solving skills, mathematical skills, conceptual understanding and integration of topics are being addressed.

Graph 3.1.1(a) Overall Achievement Rates in Technical Sciences (Percentage)



Graph 3.1.1(b) Performance Distribution Curves in Technical Sciences (Percentage)



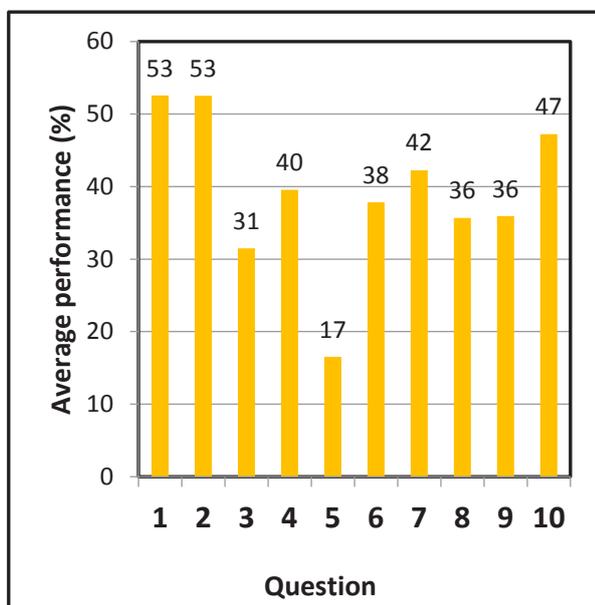
3.2 OVERVIEW OF LEARNER PERFORMANCE IN PAPER 1

General Comments

- The multiple-choice items in Q1 and the questions on Newton's First Law of Motion (Q2), Momentum (Q4), Elasticity, Hydraulics and Viscosity (Q7) as well Transformers and Generators (Q10) were generally well answered.
- In general Q3, Q5, Q8 and Q9 were poorly answered. Q3 examined Newton's Second and Third Laws; Q5 focused on Momentum and Impulse; Q6 dealt with Work, Energy and Power; Q8 examined Electronics and Electric Circuits and Q9 was on Electromagnetic Induction.
- In Q7 which covered Elasticity, Hydraulics and Viscosity, was fairly answered.
- Candidates performed poorly on questions pertaining to pure recall of content. Teachers are advised to use informal assessment tasks to reinforce basic concepts and principles by using, for example, short speed tests (± 10 minutes). This can be used for content relating to definitions and laws listed in the CAPS and the examination guidelines.
- Compared to 2018 candidates have generally improved in drawing and labelling free-body diagrams. However, some candidates are still struggling in this regard. The drawing of free-body diagrams is central to solving problems involving forces acting on objects and 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.

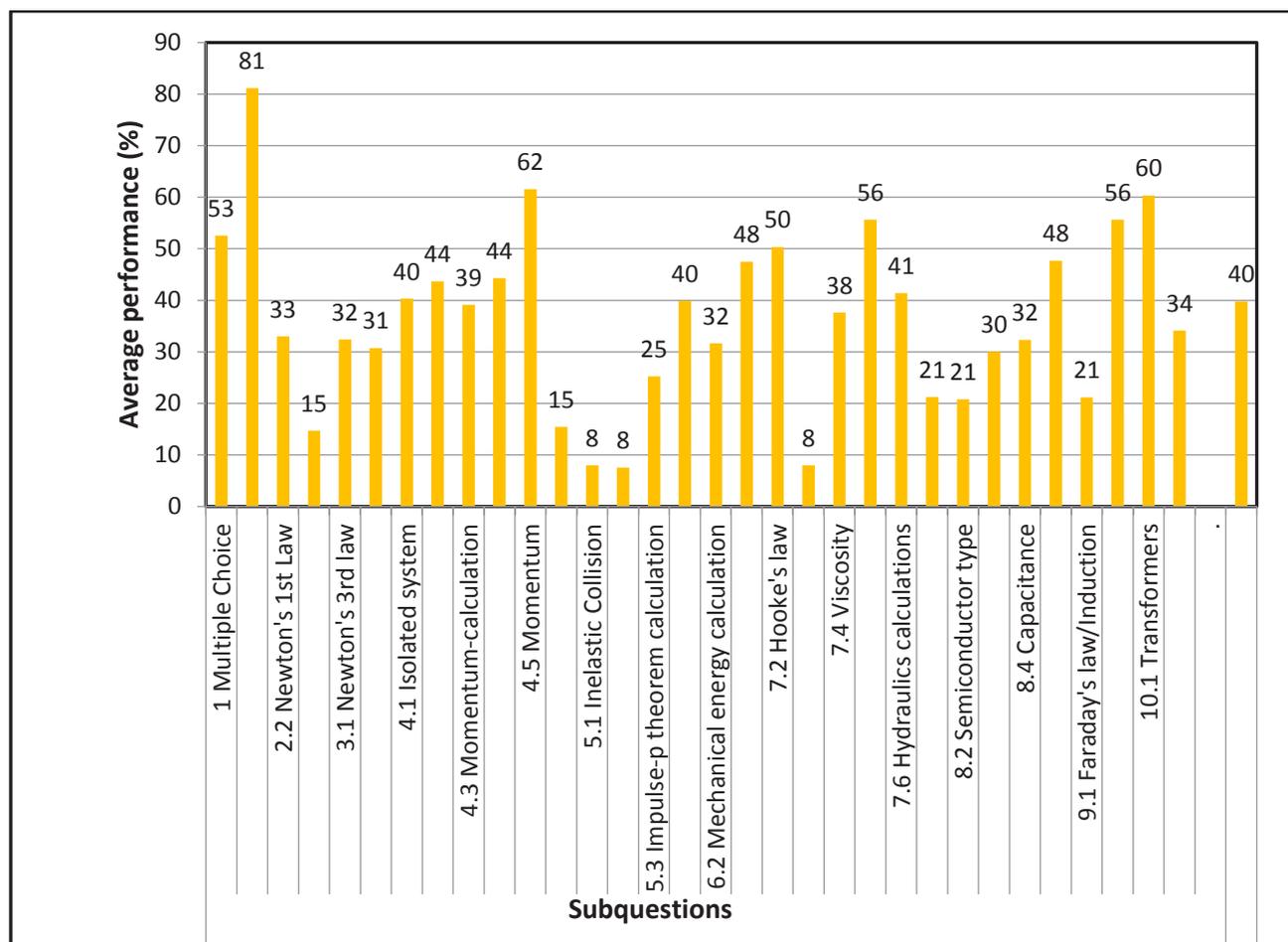
- (f) The application of mathematical principles is a challenge for many learners, such as understanding and using formulae and scientific notation as well as interpreting and representing direction in terms of a positive and negative sign. Learners should be given a variety of problem-solving activities that involve mathematical skills pertaining to fractions, manipulating the subject of the formula and graphs in formal and informal activities. The correct calculator skills and writing down the answer with the correct units and direction, where applicable, must also be emphasised.
- (g) Learners must be able to interpret and answer questions based on a variety of action verbs. Refer to the *Examination Guidelines* (Blooms' taxonomy).
- (h) Correct definitions and laws should be enforced during daily teaching and learning. Teachers should include at least multiple-choice items, definitions and laws as well as structured questions on the various topics in formal and informal activities on a regular basis. This is to enhance a deeper understanding of science concepts and content knowledge as well as to take remedial action.
- (i) Enhance teaching and learning by means of teaching aids, such as models, pictures, drawings, diagrams, videos, simulations as well as experiments and demonstrations. Learners must also be able to analyse information and answer questions based on diagrams and graphs.
- (j) Learners must be given enough activities to practise correct conversion of units. Rounding off must be done as instructed.
- (k) Learners must be exposed to the correct use and understanding of subscripts, e.g. F_{net} , W_{net} , f_k .

Graph 3.2.1 Average Marks per Question Expressed as a Percentage for Paper 1



Q. No	Topics/Aspects
1	Multiple Choice
2	Newton's First Law
3	Newton's 2nd & 3rd Law
4	Conservation of Momentum
5	Momentum and Impulse
6	Work, Power and Energy
7	Elasticity, Hydraulics & Viscosity
8	Electronics & Electric Circuits
9	Electromagnetic Induction
10	Generators & Transformers

Graph 3.2.2 Average Marks per Subquestion Expressed as a Percentage for Paper 1



3.3 ANALYSIS OF LEARNER PERFORMANCE IN EACH QUESTION IN PAPER 1

QUESTION 1: MULTIPLE CHOICE

Common Errors and Misconceptions

- (a) In Q1.2 most candidates could not analyse and derive an equation that best represents the forces that are acting on the object. Application of Newton's Second Law when the force is exerted at an angle, was not well understood.
- (b) In Q1.3 most candidates did not recognise the fact that the net force is equal to the rate of change in momentum.
- (c) In Q1.4 candidates failed to apply the sign conversion in terms of the direction in an equation $\Delta p = mv_f - mv_i$.
- (d) In Q1.8 the candidates who struggled with superscripts and understanding the notation normally used for symbols such as $C \cdot V^{-1}$ (instead of $\frac{C}{V}$ or C/V), did not perform well in this question. Many candidates chose option A or B. They did not realise that they could use the data sheet to answer this type of question.

Suggestions for Improvement

- (a) Teachers must train learners to work out answers in multiple-choice questions rather than relying on guess work.
- (b) Learners must be exposed to higher-order questions where they analyse complex problems and create solutions.
- (c) Teachers must use various formulae to teach the relationship between different variables. Learners must be trained on how to interpret various equations and explain the relationship between variables.
- (d) Sign conversions in terms of the direction when substituting in a formula and writing the final answer must be fully explained to learners.
- (e) Learners must be taught to use formulae to determine equivalence units of various quantities. They should also be encouraged to refer to the formula sheet for summaries of laws and basic principles.

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

Common Errors and Misconceptions

- (a) In Q2.1.1 some candidates labelled f_s as f_k , despite the fact that the toolbox was not moving. Others drew more than four forces (the mark allocation required only 4). A few candidates drew unlabelled diagrams, lines without arrows or dotted lines. Incorrect labels like w instead of W or g instead of F_g were used.
- (b) In Q2.1.2 candidates did not state Newton's First Law of Motion as they could not relate the given situation to the law. Those who could identify that Newton's First Law was involved, gave the name of the law instead of stating it. Some of those who stated the law omitted keywords like uniform velocity and resultant force.
- (c) Most candidates could not use the law to explain a situation as required by the question; instead they simply stated the law.

Suggestions for Improvement

- (a) Teachers must explain and emphasise the difference between f_k and f_s . They must insist that learners use labelled arrows, not just lines or broken lines and the number of forces must correlate with the mark allocation.
- (b) Train learners to state the laws without omitting keywords.
- (c) Learners should be exposed to the application of principles of physics by providing an explanation using daily real-life situations.

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

Common Errors and Misconceptions

- (a) In Q3.1.1 most candidates wrote *force A* instead of *object A* and some omitted keywords like *equal magnitude* and *opposite direction*.
- (b) In Q3.1.2 candidates committed the following errors:
- Writing $F = mg$ instead of $F = ma$ or omitting the subscript *net*.
 - Substituting a as 9.8 m.s^{-2} .
 - Failing to choose direction.
 - Calculating $F_{B \text{ ON } A}$ only.
 - Failing to realise that $F_{B \text{ ON } A} = F_{A \text{ ON } B}$ but in an opposite direction.
 - Assuming that the two crates had the same μ_k while it was not stated. They also failed to recognise that F of object **A** on object **B** would be equal but in opposite direction to force of object **B** on **A**.
- (c) In Q3.2.1 most candidates omitted the phrase *net force*.
- (d) In Q3.2.2 the majority of candidates wrote the formula as $F = mg$ and $F = ma$ omitting the subscript *net*. Some candidates could not correctly identify all forces acting in each of the trolleys.
- (e) In Q3.2.3 and Q3.2.4 candidates struggled to explain why the frictional force would decrease when the force that was acting horizontally was changed to act at an angle. They failed to reason out the relationship between the normal force and the frictional force when there is the introduction of a vertical force.

Suggestions for Improvement

- (a) Teachers must teach learners to state the laws without omitting keywords. Laws and principles should be thoroughly drilled.
- (b) Learners must be exposed to various questions that require calculation and application of the laws. It must be explained that action-reaction pairs work simultaneously in two objects and that they have equal magnitudes but act in opposite directions.
- (c) Teachers must use the formula of $f_k = \mu_k N$ to explain the relationship between normal force and frictional force. Learners must be taught to explain their answers to questions as this will augment scientific reasoning.

QUESTION 4: CONSERVATION OF MOMENTUM

Common Errors and Misconceptions

- (a) In Q4.1 most of the candidates omitted the words, *net* or *external* when defining an isolated system.
- (b) In Q4.2 the majority of candidates calculated change in momentum instead of momentum. Some lost 1 mark as they omitted the direction in the final answer.
- (c) In Q4.3 some candidates incorrectly used formula $\Delta p = mv_f - mv_i$ or $F_{\text{net}} \cdot \Delta t = \Delta p$ instead of $\Sigma p_i = \Sigma p_f$.
- (d) In Q4.4 keywords like *conservation*, *linear*, *isolated system* and *total* were omitted from the law by many candidates. Others just stated the law without naming it.
- (e) In Q4.5 and Q4.6 candidates failed to apply the relationship between *momentum* and *speed* to answer these questions. Others provided options that were not in the question paper.

Suggestions for Improvement

- (a) Teachers must train learners on how to state the law in full without omitting keywords. Learners must also be taught to distinguish between *naming* and *stating*.
- (b) Learners must be trained on calculations; emphasis should be placed on choosing the correct formula, substitution, correct answers with correct units and direction in case of vectors.
- (c) Teachers should ensure that learners are fully familiar with the data sheet and how to identify the relevant equation applicable to a specific calculation. They should make use of the data sheet during daily homework exercises.
- (d) The relationship between the *momentum* and the *speed* of an object must be explained fully.

QUESTION 5: MOMENTUM AND IMPULSE

Common Errors and Misconceptions

- (a) In Q5.1 most candidates could not define the term *inelastic collision*. Some omitted the keywords like *total* or just explained the concept in terms of conservation of total linear momentum or conservation of total kinetic energy only.
- (b) In Q5.2 the majority of candidates omitted the word *rate*. Some defined *net force* in terms of momentum as the product of mass and acceleration instead of defining it as the rate of change in momentum.
- (c) In Q5.3 many candidates failed to choose the correct formula from the data sheet; others did not write the direction in the final answer thus losing 1 mark.

Suggestions for Improvement

- (a) Teachers must train learners on how to state laws, principles and definitions without omitting keywords.
- (b) They should give learners many practice exercises on calculations involving momentum and impulse.

QUESTION 6: WORK, ENERGY AND POWER

Common Errors and Misconceptions

- (a) In Q6.1 several candidates struggled to define *mechanical energy*. Some omitted keywords like *sum* and *gravitation*.
- (b) In Q6.1.2 some candidates missed the fact that the velocity at 17 m above the ground was $3 \text{ m}\cdot\text{s}^{-1}$.
- (c) In Q6.1.3 most candidates had difficulty in establishing that after falling for 11 m, the height of an object was 6 m, i.e. $17 - 11 = 6 \text{ m}$.
- (d) In Q6.1.4 the majority of candidates used the symbol Σ in front of E_M or M_E and forfeited all marks even though substitutions and answers were correct.
- (e) In Q6.2.1 a large number of candidates did not use the formula $P_{\text{ave}} = Fv_{\text{ave}}$, despite the fact that the formula was on the formula sheet.
- (f) Most candidates could not calculate the power from the given information; it might be that they have not been exposed to these kinds of problems. They also failed to convert watt to horsepower. Some of them omitted the units from their answers.

Suggestions for Improvement

- (a) Teachers must ensure that learners do not omit keywords in definitions as prescribed in the *CAPS* and *Examination Guidelines*.
- (b) Learners must be taught to analyse the given information carefully and extract the required information. They must also be taught the skills required to answer a variety of questions.
- (c) Conversions of units to and from SI units must be revised and the writing of units in the final answer must be emphasised.

QUESTION 7: ELASTICITY, HYDRAULICS AND VISCOSITY

Common Errors and Misconceptions

- (a) When defining *elasticity* (Q7.1.1) most candidates omitted keywords like *ability, property, original* and *deforming force is removed*.
- (b) In Q7.1.2 and Q7.1.3 most candidates failed to convert the given prefixes of units into numerical values.
- (c) In Q7.1.3 some candidates wrote the units in the final answer, which was not required.
- (d) In Q7.3 candidates failed to list the *perfectly elastic bodies*. They only wrote the *elastic* bodies.
- (e) In Q7.6.1 and Q7.6.2 some candidates failed to convert the given information into values corresponding with the correct SI units. Some failed to calculate the area while others omitted the units in the final answer.

Suggestions for Improvement

- (a) Teachers must insist that learners write the definitions and state the laws as they are given in the CAPS.
- (b) Learners must be exposed to a wide range of examples of perfectly elastic bodies. A clear distinction must be drawn between *elastic, perfectly elastic, plastic* and *perfectly plastic bodies*.
- (c) Conversions of units must be revised rigorously. Teachers must also emphasise the numerical values of the prefixes of units like *kilo-, milli- and mega-*.
- (d) Learners must also be exposed to multi-step calculations.

QUESTION 8: ELECTRONIC PROPERTIES OF MATTER AND ELECTRIC CIRCUITS

Common Errors and Misconceptions

- (a) In Q8.1 some candidates omitted the word *material* or *conductivity* in the definition of semiconductor.
- (b) When answering Q8.2 many responses included p-type, n-type, p-n semiconductors, isolator and impurities instead of intrinsic semiconductor.
- (c) The candidates' responses showed that they do not understand the difference between a *p-type* and an *n-type semiconductor* in Q8.3.2.

- (d) Candidates were unable to convert cm^2 to m^2 and mm to m . Hence, incorrect answers were written in Q8.4.1. Most candidates used the formula $C = Q/V$ to calculate capacitance. Incorrect units and unconventional abbreviations like amp/Amps were used.
- (e) In Q8.4.2 and Q8.4.3 candidates could not explain the relationship between *capacitance* and *distance*.
- (f) Candidates incorrectly manipulated Ohm's law when calculating current. They wrote an incorrect SI unit for current and incorrect units.
- (g) In Q8.5.2 candidates could not explain the relationship between *current* and *heat*.
- (h) Most candidates were unable to give examples in which the heating effect of current is used. Their responses included ammeter, voltmeter, current, light bulbs, alarm systems and microwave, alarm systems, etc.

Suggestions for Improvement

- (a) All concepts, definitions, terminology, laws and principles should be correctly stated as specified in the CAPS and Examination Guidelines.
- (b) The difference between *intrinsic* and *extrinsic semiconductors*, as well as the difference between a *p-type* and an *n-type semiconductor* must be emphasised.
- (c) Teachers should ensure that learners are fully familiar with the data sheet and are able to identify the relevant equation applicable to a specific calculation. Conversions of units and correct SI units must form an integral part of teaching and learning.
- (d) The relationship between variables should be explained.
- (e) Practical applications of the heating effect should be taught and assessed in informal and formal activities.

QUESTION 9: ELECTROMAGNETIC INDUCTION

Common Errors and Misconceptions

- (a) In Q9.1.1 some candidates omitted to state Faraday's Law.
- (b) In Q9.1.2 most candidates phrased their answers incorrectly while others omitted keywords.
- (c) In Q9.2 the majority of candidates were able to calculate the magnetic flux linkage even though they did not get the SI unit.

Suggestions for Improvement

- (a) Teachers must teach learners to state the laws as stated in the *CAPS* and *Examination Guidelines*.
- (b) Learners must be taught to state the relationship between the magnetic strength, number of turns, speed at which the magnet is moving in and out of the coil or increase number of turns/windings and the magnitude induced emf.
- (c) Emphasise the writing of units in the final answer.

QUESTION 10: GENERATORS AND TRANSFORMERS

Common Errors and Misconceptions

- (a) Candidates were unable to differentiate between *step-down transformer* and *step-up transformer* in Q10.1.
- (b) Candidates omitted subscripts when writing the formula $\frac{V_S}{V_P} = \frac{N_S}{N_P}$
- (c) In Q10.1.2 candidates struggled with mathematical manipulation to get the correct answer.
- (d) Candidates could not differentiate between *AC* and *DC generators*.
- (e) Most candidates could not identify a component that enables the generator to produce DC voltage in Q10.2.2.

Suggestions for Improvement

- (a) Teachers should tabulate the difference between a *step-up* and a *step-down transformer*, by making use of pictures, models and videos to help learners gain a better understanding. Teach learners that the input voltage is the primary voltage and the output voltage is the secondary voltage.
- (b) The importance of subscripts in the equations should be emphasised.
- (c) Compare motors and generators in a table when teaching the topic as well as AC and DC generators.
- (e) Teach learners the components of generators and motors as well as the function of each component. The terminology associated with motors and generators, e.g. slip-rings, commutator and brushes should be emphasised. Use examples of actual motors and generators, models, drawings, pictures and simulations.

3.4 DIAGNOSTIC QUESTION ANALYSIS OF PAPER 2

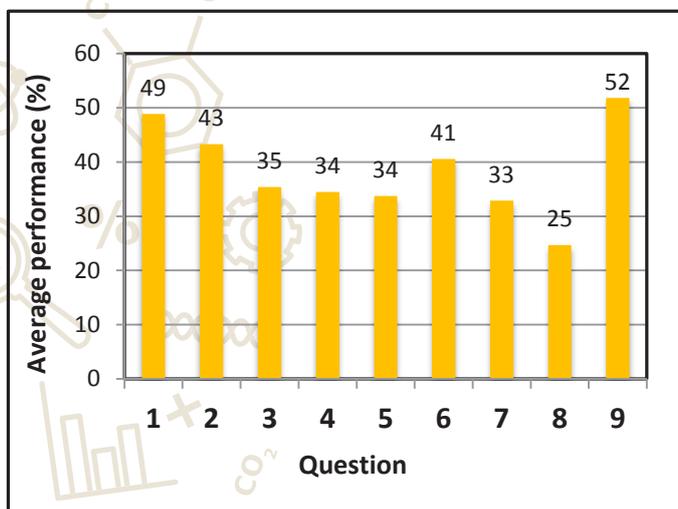
General Comments

- (a) Questions on definitions were poorly answered. Teachers are advised to teach and assess definitions as stated in the *CAPS* and *Examination Guidelines*.
- (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 light in Q7 and Q8 were poorly answered.
- (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 conversion of units in Q9.
- (g) The interpretation and the use of the table of standard reduction potentials posed a challenge to candidates.
- (h) Candidates struggled with the rules of assigning oxidation numbers, as taught in Grade 11.
- (i) Teachers must encourage learners to read the questions and follow instructions.

3.5 DIAGNOSTIC QUESTION ANALYSIS OF PAPER 2

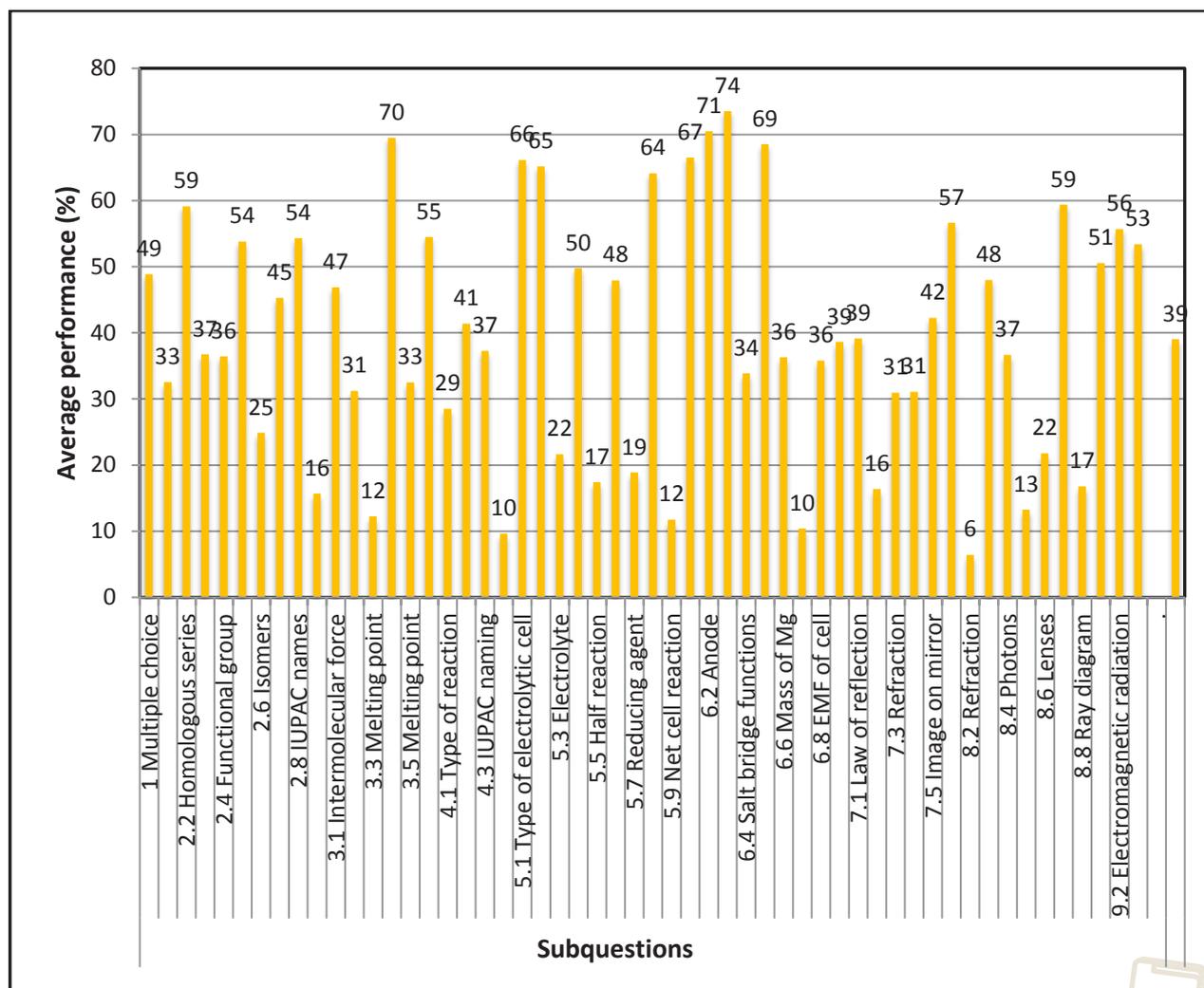
The following graph is based on data from a random sample of candidates. While this graph might not accurately reflect national averages, it is useful in assessing the relative degrees of challenge of each question as experienced by candidates.

Graph 2.5.1 Average Marks per Question Expressed as a Percentage for Paper 2



Q1	Multiple Choice
Q2	Organic Molecules: Nomenclature
Q3	Organic Molecules: Physical Properties
Q4	Organic molecules: Reactions
Q5	Electrolytic cell
Q6	Galvanic cell
Q7	Light: Reflection and refraction
Q8	Light: Reflection and refraction
Q9	Electromagnetic radiation

Graph 2.5.2 Average Marks per Subquestion Expressed as a Percentage for Paper 2



3.6 ANALYSIS OF LEARNER PERFORMANCE IN EACH QUESTION IN PAPER 2

QUESTION 1: MULTIPLE CHOICE

Common Errors and Misconceptions

- In Q1.2 candidates could not recall that alkanes have weaker intermolecular forces and as such are used as fuel.
- Some candidates did not recognise that hydrogen was added to form the product in Q1.4. They could not identify the product formed during the addition of but-2-ene.
- Many candidates failed to identify the oxidation number of chlorines in CuCl_2 in Q1.6.
- In Q1.8 candidates struggled to relate the properties of image and the position of the object when using a convex lens.
- Most candidates could not relate the degree of refraction with the frequency or wavelength of light in Q1.9.

Suggestions for Improvement

- (a) The different types of reactions should be thoroughly taught and reference should be made to the CAPS and the *Examination Guidelines* to determine which reactions to teach.
- (b) Revise the Grade 11 work, which is examinable in Grade 12, on rules for assigning oxidation numbers. The periodic table must be attached to the question paper.
- (c) The drawing of ray diagrams and identification of properties of images should be emphasised.
- (d) Emphasis must be placed on the fact that the extent to which light refracts is related to the wavelength of light. Learners also need to be able to arrange spectrum in order of increasing or decreasing wavelength or frequency. Experiments on the refraction of light should be conducted to emphasise the content taught. Daily activities, informal and formal assessment should include multiple-choice questions. Educators are encouraged to compile a test bank of MCQs for learners.

QUESTION 2: NAMING OF ORGANIC MOLECULES AND STRUCTURAL FORMULAE

Common Errors and Misconceptions

- (a) In Q2.1 candidates left out the word *organic* in the definition for homologous series.
- (b) When explaining *saturated compound* in Q2.3, candidates omitted the word 'only' to qualify that there were no other bonds except single bonds.
- (c) Candidates could not define the term *functional group* in Q2.4.
- (d) Candidates could not identify the correct pairs in Q2.5.4 and the type of isomers in Q2.5.5. Those who correctly identified the pairs failed to give the correct names of the types of isomers of these pairs.
- (e) In Q2.7.2 many candidates could not draw the structural formula of the functional group of esters. Instead they wrote 'ester linkage', or failed to include some of the bonds around the carbon atom or the oxygen atom.
- (f) In Q2.3.6 candidates struggled to draw the structural isomer of compound D.
- (g) When naming compounds in Q2.8.1 and Q2.8.2, candidates either left out the hyphen or placed it in the wrong place.
- (h) Most candidates struggled to define the term *polymer* in Q2.9.1.

Suggestions for Improvement

- (a) Greater emphasis should be placed on the learning of definitions as stated in the CAPS and the examination guidelines and it should be assessed in informal and formal activities.

- (b) Differentiate, using examples, the functional group, functional group name and homologous series. Learners must be taught to read the information in the question carefully and follow instructions precisely.
- (c) The structural formula of the functional groups from the different homologous series should be emphasised and form part of the daily assessment activities.
- (d) Teach learners the difference between homologous series and functional groups of different organic compounds.
- (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) Candidates wrote *Van der Waals forces* instead of being specific about the type of intermolecular force in Q3.1.
- (b) In Q3.2 candidates linked longer chain length with weaker intermolecular forces. They failed to identify which one of the two compounds is more branched and they could not relate the influence of branching to the strength of intermolecular forces. They also stated that more energy is needed to 'break' the 'bond' or 'substance' of intermolecular forces instead of saying 'overcoming' intermolecular forces. Some used the phrase 'less/lower forces' instead of 'weaker' or 'stronger intermolecular forces'.
- (c) In Q3.3 candidates struggled to define the term *melting point*. They left out keywords in the definition like temperature and *equilibrium*.
- (d) In their explanation in Q3.5 candidates incorrectly indicated that the 'higher the boiling point, the lower the melting point'. They did not seem to understand the relationship between boiling point, melting point and the strength of the intermolecular forces.
- (e) Candidates could not identify the types of intermolecular forces and compare the strength of the forces in ethane and ethanol in Q3.4.

Suggestions for Improvement

- (a) Learners should be taught definitions including all necessary keywords. Informal tests should be used to assess definitions regularly.

- (b) The strength and the type of intermolecular forces acting on different organic compounds (homologous series) should be clearly explained.
- (c) Candidates must be guided on how to use chain length, strength of the intermolecular forces and energy to explain trends in physical properties of organic compounds. Teachers need to use a variety of questions which require explanations in informal and formal activities.
- (d) Learners must be taught which factors (chain length, branching, type of intermolecular force, homologous series) from the given structures influence the strength of intermolecular force. In addition, they must also be taught to be specific when making comparisons.
- (e) Teachers must emphasise the fact that the stronger the intermolecular force, the more energy will be needed to overcome the intermolecular force instead of breaking the bond or substance.
- (f) When comparing two compounds, learners should be taught to be specific and to mention both compounds rather than being too general.
- (g) The relationship between *boiling point* and *melting point* should be explained; substances with high boiling points have high melting points and vice versa.
- (h) The types of intermolecular forces, strength of the intermolecular forces and the energy involved must be used to explain the trends of physical properties of organic compounds.

QUESTION 4: REACTIONS OF ORGANIC COMPOUNDS

Common Errors and Misconceptions

- (a) In Q4.1, Q4.2.1, Q4.2.2 candidates could not name and differentiate between the different types of reactions.
- (b) In Q4.3.2 candidates struggled to name compound **B** which was Butan-2-ol. They wrote But-2-ol or But-2-anol and even omitting the hyphen or '2' which is the position of the functional group.
- (c) In Q4.3.3 candidates omitted the hyphen or placed it in the wrong position, e.g. 2 bromobutane or 2-bromo-butane, 2 bromo-butane. The position of Br was also omitted or incorrectly written as bromo-2-butane.
- (d) In Q4.4 candidates were unable to state the reaction conditions for the substitution reaction of the haloalkanes. Some wrote 'heat' without indicating that it is *mild* heat.

Suggestions for Improvement

- (a) During teaching, emphasise differentiating between the different types of reactions (combustion/oxidation, substitution reactions and the different types of addition reactions) as well as their reaction conditions.

- (b) 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.
- (c) Although the rules, viz. Zaitsev's Rule and Markovnikov's Rule, are not examinable, their applications should be stressed to learners to help them identify minor and major products in organic reactions.

QUESTION 5: ELECTROLYTIC CELL

Common Errors and Misconceptions

- (a) Many candidates could not identify the type of cell in Q5.1. Those who did, used the word *electrolysis* instead of *electrolytic cell*.
- (b) Candidates could not define the term *electrolyte* in Q5.3; they confused *electrolyte* and *electrolysis*.
- (c) Candidates could not define *oxidizing agent* in Q5.6.
- (d) In Q5.4 candidates could not tell whether the Cu^{2+} is the anion or the cation.
- (e) In Q5.5.1 and Q5.5.2 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.
- (f) In Q5.7 candidates were unable to identify the reducing agent; those who managed to identify it omitted the ions (-) in *Cl*.
- (g) Candidates were unable to write down the overall cell reaction in Q5.9; they omitted ions. Some left out charges on ions, e.g. *Cu* instead of Cu^{2+} and *Cl* instead of Cl^- .

Suggestions for Improvement

- (a) The difference between *electrolytic* and *galvanic cell* must be emphasised.
- (b) Definition of the concepts should be explained and assessed regularly.
- (c) 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.
- (d) Perform experiments of a variety of electrolytic reactions and teach learners how to make observations.

QUESTION 6: GALVANIC CELL

Common Errors and Misconceptions

- (a) In Q6.1 candidates confused the definition of a galvanic cell with that of an electrolytic cell.
- (b) When asked for functions of the salt bridge in Q6.4, candidates just wrote 'maintains neutrality' or 'allows the movement of ions' which was not enough to allocate marks. When writing down functions of the salt bridge, they used words incorrectly, e.g. 'It completes the cells' instead of 'It completes the circuit'.
- (c) It was evident in Q6.6 that candidates could not explain why the mass of the magnesium decreased.
- (d) In Q6.7 candidates struggled to write the net reaction of the cell even though the half-reactions were given in the question paper. Those who managed to write the correct net reaction of the cell were unable to balance the equation. They also left out the ions. Some thought that the reaction was between magnesium and iron.
- (e) Most candidates swapped the anode and the cathode when substituting in the formula during calculation of the emf of the cell in Q6.8. In some cases the incorrect electrode potential was used. 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.
- (f) In Q6.9.1 candidates struggled to give alternative sources of energy. They were also unable to provide the advantages of using biodiesel in Q6.9.2.

Suggestions for Improvement

- (a) Teachers should differentiate between the definitions of galvanic and electrolytic cells.
- (b) Learners must be taught that the main functions of the salt bridge are to maintain electrical neutrality of the electrolyte through the movement of ions and to complete the circuit.
- (c) It should be emphasised that the electrode which undergoes oxidation is the one that experiences loss of mass (anode).
- (d) Emphasis should be on the different types of alternative sources of energy, and the advantages and disadvantages of using the different alternative energies.
- (e) Teachers should ensure that learners understand how to use the table of standard reduction potentials to write half-reactions, net cell reaction and they should be able to identify and compare the strength of the reducing and the oxidizing agents. Learners must use formulae as they appear on the data sheet.
- (f) The environmental advantages and disadvantages of using alternative energies should be taught and assessed.

QUESTION 7: REFLECTION OF LIGHT

Common Errors and Misconceptions

- (a) In Q7.1 candidates could not state the law of reflection or they stated only one part of the law. Some confused the concepts of *reflection* and *refraction*.
- (b) Candidates could not tell how the angle of the light ray should be incident on the rectangular glass block for it to emerge from the opposite side of the block without being refracted in Q7.2. Some wrote 90° without an explanation.
- (c) Candidates did not know that during refraction the angle of incidence is equal to the angle of emergence and the incidence ray must be parallel to the emergent ray. They did not label the light rays but labelled only the magnitudes of the angles. Rays were drawn without arrows to indicate the direction, and they were not labelled.
- (d) In Q7.4.1 candidates struggled to define *critical angle*.
- (e) Candidates identified the phenomenon in Q7.4.4 as 'internal reflection' or 'reflection or refraction' instead of 'total internal reflection' and they were unable to define it in Q7.4.5. They confused the definition of *total internal reflection* with its conditions.
- (f) Candidates struggled to identify the type of image formed in a flat mirror in Q7.5.1.

Suggestions for Improvement

- (a) The definition of the concepts *reflection* and *refraction* and laws should be emphasised using the *Examination Guidelines* and the *CAPS*. The difference between the concepts *reflection* and *refraction* should be clarified.
- (b) Teach and use practical activities to demonstrate what happens when light moves through different media or is reflected in mirrors and prisms. Scientific reasoning should be emphasised when answering questions such as differentiating between *reflection* and *refraction*.
- (c) Formal and informal assessment activities should include drawing and labelling of ray diagrams.
- (d) Learners should differentiate between the definitions and conditions of total internal reflection.
- (e) Ensure that learners know the properties of real and virtual images.

QUESTION 8: REFRACTION OF LIGHT

Common Errors and Misconceptions

- (a) Candidates could not relate wavelength/frequency to the dispersion of white light in Q8.2. Some wrote *wavelength* and *frequency* without any justification.
- (b) In Q8.3 most candidates wrote 'ROYGBIV' instead of 'spectrum'.
- (c) In Q8.5 candidates could not explain why green light had a higher energy than yellow light using frequency and wavelength.
- (d) Candidates struggled to give the correct answer to the observation in Q8.6.
- (e) In Q8.8 candidates could not draw the ray diagram through a convex lens. The extrapolation was not done until at F. The image and object did not have arrows; the position of the image was on the other side of the concave lens.
- (f) Some candidates used a convex lens instead of a concave lens in Q8.8.

Suggestions for Improvement

- (a) Refraction, including dispersion, spectrum and the relationship between frequency and wavelength to the degree of refraction, needs to be emphasised. Use various teaching aids such as videos, models and demonstrations during experiments using an optical kit. Teach learners to observe and explain observations scientifically.
- (b) Teachers must ensure that they thoroughly teach and assess the drawing of ray diagrams for convex and concave lenses. Teach the applicable terminology such as *focal point*, *focal length* and *principal axis* as well as the list of properties of images formed by these lenses at various positions from the optical centre of the lenses.
- (c) Teach learners the difference between a *virtual* and a *real image*.
- (d) Applications of lenses should be taught.

QUESTION 9: ELECTROMAGNETIC WAVES

Common Errors and Misconceptions

- (a) Candidates struggled with the definition of a photon in Q9.1. Most of candidates omitted the word *packet/quanta* of energy in the definition of a photon.
- (b) In Q9.3 candidates could not correctly convert the wavelength from nanometres to metres. Some did not even convert the wavelength to metres and substituted the wavelength in nanometres.
- (c) Wrong rounding off and the omission of SI units in the final answer were evident in Q9.3.

Suggestions for Improvement

- (a) The definitions of concepts should be emphasised using the *Examination Guidelines* and the *CAPS*. Teachers should highlight keywords in definitions while teaching.
- (b) 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 2019 examinations.

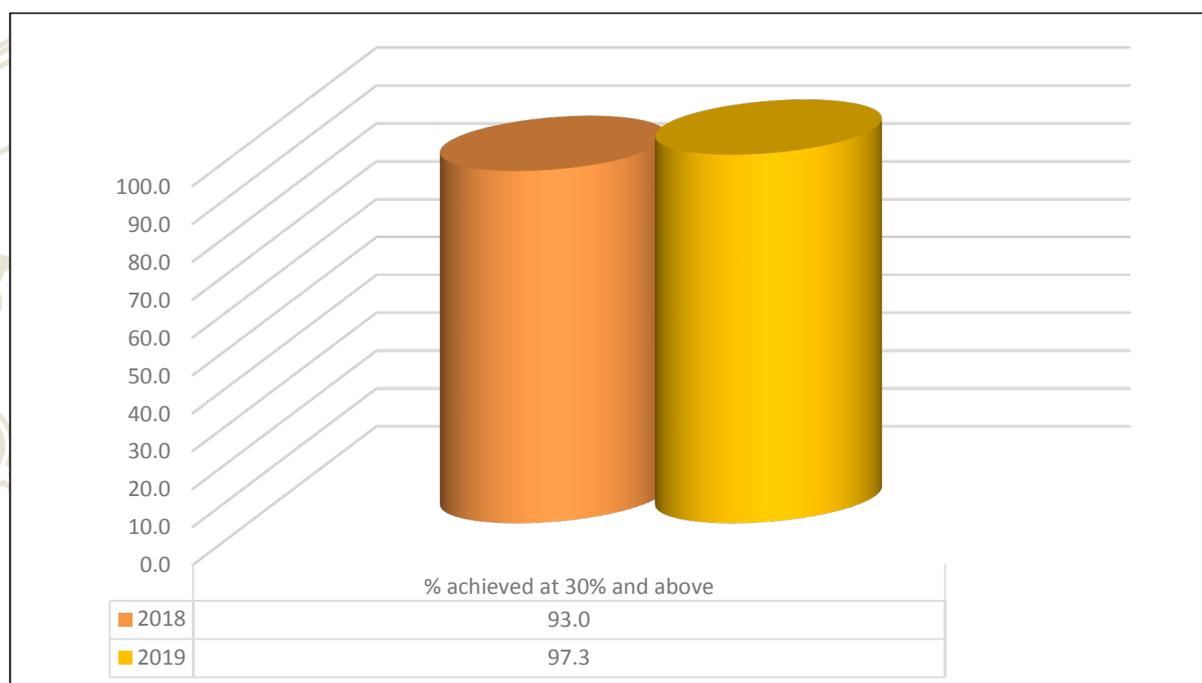
4.1.1 PERFORMANCE TRENDS (2018–2019)

In 2019, 582 candidates sat for the Civil Services examination which is 213 fewer candidates than in 2018. The performance of the candidates in 2019 shows a pleasing improvement compared to the performance in 2018.

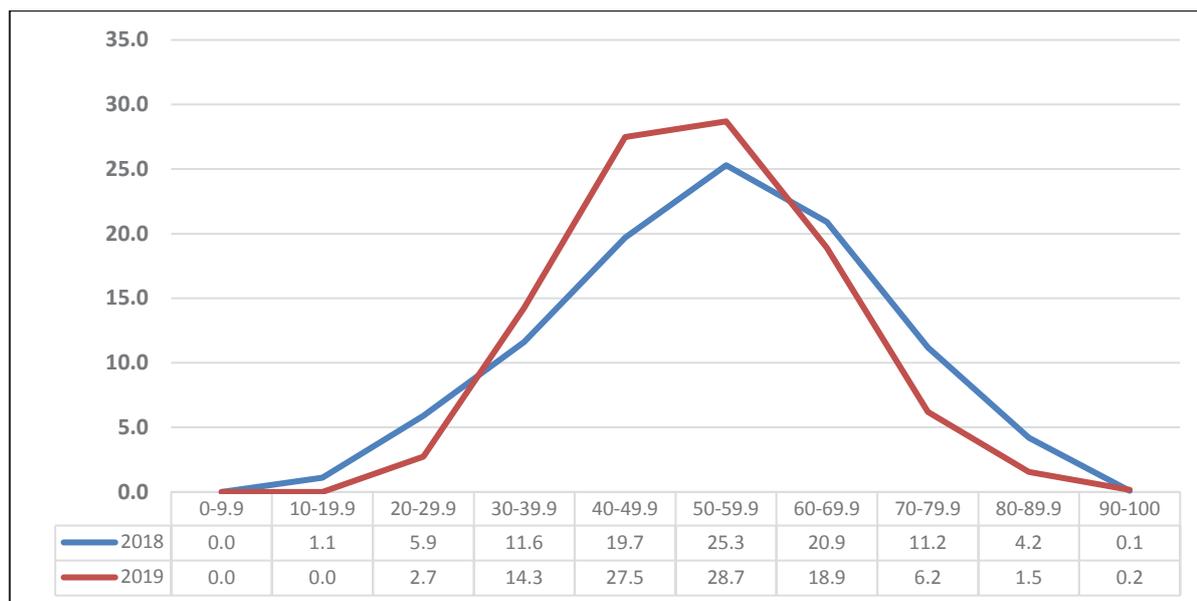
Table 4.1.1 (a) Overall Achievement Rates in Civil Services

Year	No. Wrote	No. achieved at 30% and above	% achieved at 30% and above
2018	795	739	93,0
2019	582	566	97,3

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 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 the multi-detector to locate objects inside a wall.*
- 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) Responses of candidates given to questions regarding safety and equipment were mostly general responses that are incorrect, instead of specific responses, e.g. candidates responded by indicating that workers should wear PPE instead of a specific item, like a hard hat.
- (i) Many candidates found it difficult to explain practical applications theoretically.
- (j) It is recommended that learners study drawings by doing the drawing freehand until they know all the parts and the sequence to follow, before they start with scale drawings.
- (k) 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.
- (l) It is important that all topics be sufficiently covered before the preparatory examinations commence.
- (m) 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 at all cognitive levels.
- (n) Learners must be aware that if the unit is not stated in their answers, they may lose marks.

4.1.3 ANALYSIS OF LEARNER PERFORMANCE IN EACH QUESTION

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

Common Errors and Misconceptions

- (a) In Q1.1 (8 marks) candidates had difficulty matching the descriptions in the matching-items question with the items. Candidates had to demonstrate deeper insight in the properties and principles applied in materials and tools than the mere identification and use thereof and were not fully equipped to respond in the required manner.
- (b) In Q1.5 (2 marks) candidates responded poorly to the question relating to the transporting of material and gave general answers related to the handling of material instead.
- (c) In Q1.6 (1 mark) many candidates responded incorrectly to the safety requirements related to scaffold planks; instead they gave responses that were pertinent to scaffolding in general.
- (d) In Q1.8.1 (1 mark) many candidates *described* the fastener instead of *identifying* it.

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 the skill of using them. The challenges of answering this type of question can 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 needs to be responded to.
- (c) Teachers should divide topics with a long list of possible answers into smaller subsections and group the relevant answers with the subtopics during teaching. Learners should be taught how to interpret and respond to this type of question.
- (d) More emphasis should be placed on the use of the correct terminology when identifying objects. It is advisable that teachers focus strongly on the use of correct terminology during teaching or when marking class and homework of learners.

QUESTION 2: GRAPHICS AS METHOD OF COMMUNICATION

Common Errors and Misconceptions

- (a) Many candidates experienced challenges to read and interpret the floor plan and elevation and they were not able to identify and interpret drawing symbols.
- (b) Poor performance by candidates was noted in Q2.2 (1 mark) where the identification of a hipped roof posed a challenge to them.
- (c) In Q2.5 (1 mark) most candidates identified the component as a door opening instead of a door.
- (d) In Q2.8 (1 mark) the majority of candidates were not able to identify the symbol of a wash trough.
- (e) Some candidates could not identify the drawing symbol in Q2.13 (1 mark).
- (f) In Q2.15 (1 mark) many candidates misinterpreted the question to name a material that should be used instead of a material that should *not* be used.
- (g) In Q2.16 (1 mark) the responses of candidates indicate that they were not familiar with the properties and uses of materials used for the production of sanitary fittings.
- (h) In Q2.27 (2 marks) a significant number of candidates could not identify the landing on the staircase and also misinterpreted the question. Instead of responding to the uses or functions of the indicated symbols on the drawing, candidates identified the symbols.
- (i) In Q2.28 (1 mark) the majority of candidates had difficulty in justifying why the floor plan was relevant to the elevation. This question required insight into the differences between a ground floor plan and that of the first floor.

- (j) In Q2.29 (1 mark) most candidates were unable to explain the consequences of not installing a sill below a window.
- (k) In Q2.31 (6 marks) many candidates could not correctly deduce the dimensions of the wall thickness and room sizes from the correct elevation. They also could not write them down next to one another and add the dimensions to obtain the total length of the wall correctly.

Suggestions for Improvement

- (a) Building plans should be used during teaching to familiarise learners with the interpretation of building plans.
- (b) Models of the profiles of the different types of roof layout should be made by learners to help them understand the shapes of the roofs when viewed from the top, front and sides.
- (c) More analytical questions and worksheets, similar to Q2 in the question paper, should be used in class.
- (d) The *SANS Code of Practice for Drawing Symbols* should be used when teaching sections that require learners to draw or identify drawing symbols used in the building industry.
- (e) Teachers should develop worksheets comprising a schedule of all drawing symbols used in the drawing of floor plans for learners to complete.
- (f) A tour of the school would be beneficial to learners to show them the different materials that can be used as trimmings around a roof.
- (g) Samples of sanitary fittings must be made available to learners to aid them with identification and to familiarise them with the properties and uses.
- (h) Learners should draw floor plans with elevations so that they can identify the elevations relevant to the sides of a floor plan.
- (i) It is recommended that teachers use correct terminology during teaching, especially when referring to units, i.e. width, length and height.
- (j) It would be beneficial to learners if teachers use copies of building plans when teaching this topic. Specific reference should be made to the different items and symbols used on building plans. It is recommended that learners be taken on an excursion to view multi-storey buildings while the teacher explains the different facets of the buildings. These facets can then be linked to the symbols and parts of a building on the building plan. Photos and videos can be used to demonstrate the different parts of a building if an excursion is not viable.
- (k) Learners should be exposed to more calculations involving area, perimeter and lengths of walls to ensure that learners have mastered the mathematical concepts.

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

Common Errors and Misconceptions

- (a) Q3.3.1 (1 mark) was poorly answered by most candidates. They were not familiar with the term *deduce* and were not able to interpret the floor plan and deduce the number of sanitary fittings from the drawing.
- (b) In Q3.3.3 (6 marks) many candidates experienced challenges to convert the units in the calculations from millimetres to metres and to calculate the volume of a cubical reservoir in litres.
- (c) In Q3.5 (3 marks) many candidates were not familiar with the equipment used to determine the route and fall of a trench.
- (d) Most candidates had difficulty to draw the consecutive course of the brick bond provided in Q3.6 (10 marks). This seemed to be because candidates were not exposed to the practical packing of brick bonds.

Suggestions for Improvement

- (a) It is advised that teachers expose learners to the academic terminology that is used in the phrasing of questions on a daily basis. A list of commonly used verbs can be given to learners and a few of these terms can be explained in every teaching period to familiarise learners with the meaning and expectations when these terms are used.
- (b) More exercises on each part of the calculations of quantities should be given to learners to enable them to master the concepts of each type of quantity that they should be able to calculate.
- (c) The lack of understanding to determine the route and fall of a trench for a sewerage pipeline can be overcome by doing this exercise practically with learners.
- (d) It is advised that learners be allowed to 'dry-pack' different brick bonds and interpret the placement of the bricks from different angles before drawing these sketches. More emphasis should be placed on the use of drawing instruments, correctness, neatness and scale or proportion of drawings during teaching.

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

Common Errors and Misconceptions

- (a) In Q4.2 (3 marks) candidates had difficulty to explain what an *airlock* is and also confused an *airlock* with a *fitting* or a *vacuum breaker*.
- (b) In Q4.3 (2 marks) candidates were not able to explain the causes of water hammer. A challenge could be that candidates did not understand what *water hammer* is and as a result could not relate to the causes thereof.

- (c) In Q4.4 (2 marks) and Q4.5 (4 marks) many candidates were not able to correctly identify and draw the required symbols.
- (d) The identification of common pipe joints, pipes and fittings used in a drainage system in Q4.6 (2 marks) and Q4.7 (4 marks) posed a challenge for many candidates.
- (e) In Q4.13 (2 marks) and Q4.14 (2 marks) candidates were not familiar with the devices and valves that were tested. Many candidates could not properly interpret the questions and gave general answers instead of addressing the precise aspects that were required in the question.

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 clearly indicate the difference between processes and principles as opposed to fittings within the subject content.
- (b) A practical demonstration will help to develop a better understanding of the causes of water hammer.
- (c) Learners will benefit if informal assessment tasks are conducted on a regular basis during each term to test the identification and drawing of symbols.
- (d) 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 with regard to their knowledge of valves can be addressed by using practical demonstrations of the different valves and devices to show the different parts, placement in a system and working principles of each valve and device.
- (e) During teaching more emphasis should be placed on the correct interpretation of questions.

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

Common Errors and Misconceptions

- (a) In Q5.1 (4 marks) most candidates were not familiar with the term *pictorial view* and were not able to do the drawing of the gutter outlet as expected.
- (b) Poor performance was recorded for the drawing of the development of the pyramid in Q5.4 (20 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 with regard to the starting point of the development and started at a corner instead of the middle of the side where the seam was indicated.
- (c) Many candidates did not show construction lines on the drawing.

Suggestions for Improvement

- (a) It will benefit learners if a sample of a gutter outlet is made available in class so that learners can draw a freehand sketch of exactly what they see.
- (b) Workshops on the development of cones and pipes, conducted by subject specialists, will be beneficial to the development of teachers. Making paper or cardboard models of the developments listed in the CAPS will assist learners with their understanding of these concepts. Learners should be taught to use the assessment criteria provided to guide them when drawing the developments.
- (c) 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 (3 marks) most candidates experienced difficulty with drawing the sheet metal joint that was required. A possible reason may be that candidates misinterpreted the question or were not familiar with the different sheet metal joints. They tended to respond with a joint that was familiar to them.
- (b) Candidates were not familiar with the working principles of septic tanks and conservancy tanks in Q6.7 (4 marks).
- (c) Many candidates experienced challenges with the drawing of a line diagram to show the typical layout of a shower installation with two taps in Q6.8 (5 marks).
- (d) It is evident that many candidates did not know how to draw the drainage plan of a dwelling in Q6.9 (13 marks).

Suggestions for Improvement

- (a) It will benefit learners to physically produce the different types of sheet metal joints. This will enhance their understanding of the different joints and develop their skills in working with sheet metal.
- (b) It is recommended that learners be exposed to an actual septic tank and conservancy tank so that they can have a better understanding of the layout and working principles of these systems. Photographs and videos can also be used to enhance the lessons if a site visit is not possible.
- (c) It will benefit learners if teachers conduct practical demonstrations on various possible pipe layouts for shower installations and allow learners to repeat simulations of these concepts.
- (d) It is recommended that learners be taken on a site excursion around the school to show them the different parts of a sewerage system in a real-life scenario. This will assist them with understanding the function and position of each component before going into a classroom to learn how to design and draw the layout of a sewerage system.

4.2 CONSTRUCTION

The following report should be read in conjunction with the Construction question paper of the November 2019 examinations.

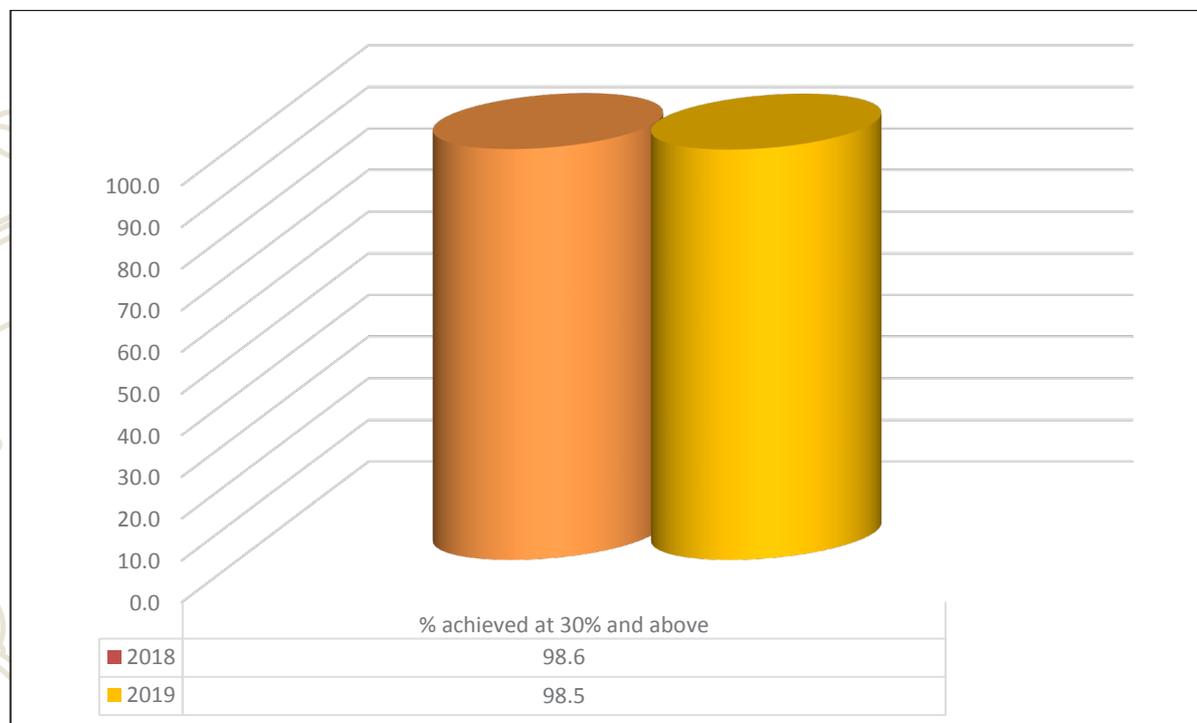
4.2.1 PERFORMANCE TRENDS (2018-2019)

In 2019, 3 492 candidates sat for the Construction examination. There was a decline in the number of learners taking the subject in 2019 probably due to the difficulty level of Technical Mathematics and Technical Sciences. The performance of the candidates in 2019 was close to the performance of learners in 2018.

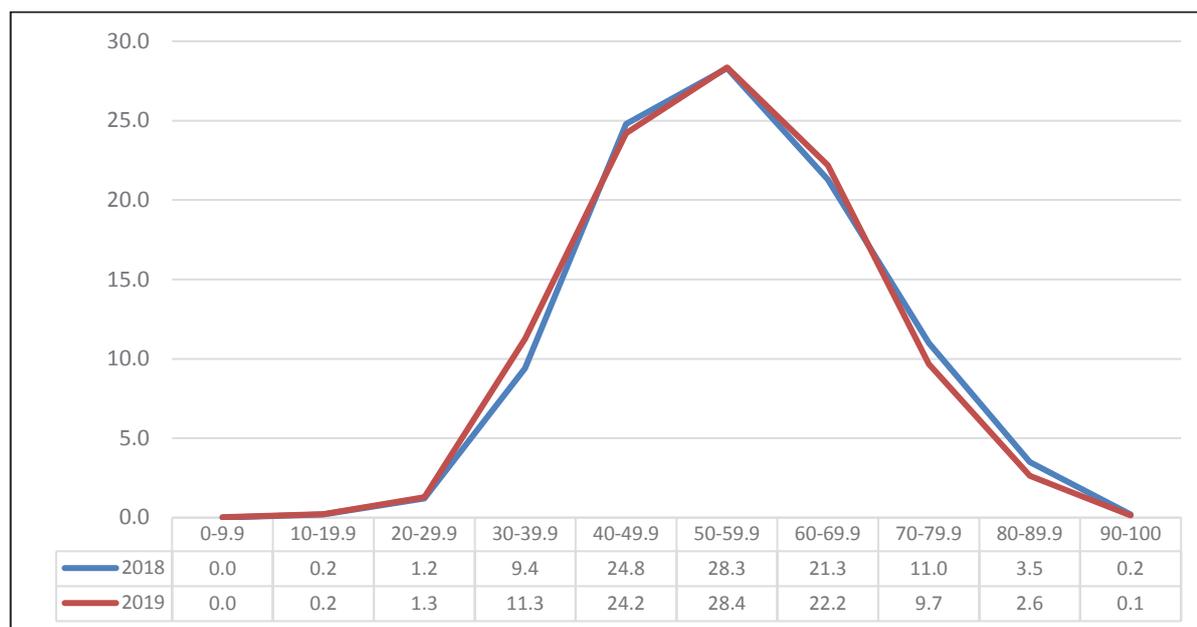
Table 4.2.1 (a) Overall Achievement Rates in Construction

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

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 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 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 sequence, e.g. *Explain how to use the multi-detector to locate objects inside a wall.*
- 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) Responses of candidates given to questions regarding safety and equipment, were mostly general responses that are incorrect, instead of specific responses, e.g. candidates responded by indicating that workers should wear PPE instead of a specific item, like a hard hat.
- (i) Many candidates found it difficult to explain practical applications theoretically.
- (j) It is recommended that learners study drawings by doing the drawing freehand until they know all the parts and the sequence to follow, before they start with scale drawings.
- (k) 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.
- (l) It is important that all topics be sufficiently covered before the preparatory examinations commence.
- (m) 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 at all cognitive levels.
- (n) Learners must be aware that if the unit is not stated in their answers, they may lose marks.

4.2.3 ANALYSIS OF LEARNER PERFORMANCE IN EACH QUESTION

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

Common Errors and Misconceptions

- (a) In Q1.1 (8 marks) candidates had difficulty matching the descriptions in the matching-items question with the items. Candidates had to demonstrate deeper insight in the properties and principles applied in materials and tools than the mere identification and use thereof and were not fully equipped to respond in the required manner.
- (b) In Q1.5 (2 marks) candidates responded poorly to the question relating to the transporting of material and gave general answers related to the handling of material instead.
- (c) In Q1.6 (1 mark) many candidates responded incorrectly to the safety requirements related to scaffold planks; instead they gave responses that were pertinent to scaffolding in general.
- (d) In Q1.8.1 (1 mark) many candidates described the *fastener* instead of *identifying* it.

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 the skill of using them. The challenges of answering this type of question can 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 needs to be responded to.
- (c) Teachers should divide topics with a long list of possible answers into smaller subsections and group the relevant answers with the subtopics during teaching. Learners should be taught how to interpret and respond to this type of question.
- (d) More emphasis should be placed on the use of the correct terminology when identifying objects. It is advisable that teachers focus strongly on the use of correct terminology during teaching or when marking class and homework of learners.

QUESTION 2: GRAPHICS AS METHOD OF COMMUNICATION

Common Errors and Misconceptions

- (a) Many candidates experienced challenges to read and interpret the floor plan and elevation and were not able to identify and interpret drawing symbols.
- (b) Poor performance by candidates was noted in Q2.2 (1 mark) where the identification of a hipped roof posed a challenge to them.
- (c) In Q2.5 (1 mark) most candidates identified the component as a door opening instead of a door.
- (d) In Q2.8 (1 mark) the majority of candidates were not able to identify the symbol of a wash trough.
- (e) Some candidates could not identify the drawing symbol in Q2.13 (1 mark).
- (f) In Q2.15 (1 mark) many candidates misinterpreted the question to name a material that should be used instead of a material that should *not* be used.
- (g) In Q2.16 (1 mark) the responses of candidates indicated that they were not familiar with the properties and uses of materials used for the production of sanitary fittings.
- (h) In Q2.27 (2 marks) a significant number of candidates could not identify the landing on the staircase and also misinterpreted the question. Instead of responding to the uses or functions of the indicated symbols on the drawing, candidates identified the symbols.
- (i) In Q2.28 (1 mark) the majority of candidates had difficulty in justifying why the floor plan was relevant to the elevation. This question required insight into the differences between a ground floor plan and that of the first floor.
- (j) In Q2.29 (1 mark) most candidates were unable to explain the consequences of not installing a sill below a window.
- (k) In Q2.31 (6 marks) many candidates could not correctly deduce the dimensions of the wall thickness and room sizes from the correct elevation. They also could not write them down next to one another and add the dimensions to obtain the total length of the wall correctly.

Suggestions for Improvement

- (a) Building plans should be used during teaching to familiarise learners in interpreting building plans.
- (b) Models of the profiles of the different types of roof layout should be made by learners to help them understand the shapes of the roofs when being viewed from the top, front and sides.
- (c) More analytical questions and worksheets, similar to Q2 in the question paper, should be done in class.
- (d) The *SANS Code of Practice for Drawing Symbols* should be used when teaching sections that require learners to draw or identify drawing symbols used in the building industry.
- (e) Teachers should develop worksheets comprising a schedule of all drawing symbols used in the drawing of floor plans for learners to complete.
- (f) A tour of the school would be beneficial to learners to show them the different materials that can be used as trimmings around a roof.
- (g) Samples of sanitary fittings must be made available to learners to aid them with identification and to familiarise them with the properties and uses.
- (h) Learners should draw floor plans with elevations so that they can identify the elevations relevant to the sides of a floor plan.
- (i) It is recommended that teachers use correct terminology during teaching, especially when referring to units, i.e. width, length and height.
- (j) It will be beneficial to learners if teachers use copies of building plans when teaching this topic. Specific reference should be made to the different items and symbols used on building plans. It is recommended that learners be taken on an excursion to view multi-storey buildings while the teacher explains the different facets of the buildings. These facets can then be linked to the symbols and parts of a building on the building plan. Photos and videos can be used to demonstrate the different parts of a building if an excursion is not viable.
- (k) Learners should be exposed to more calculations involving area, perimeter and lengths of walls to ensure that learners 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 (3 marks).
- (b) Candidates were not familiar with the word *balusters* in a staircase that resulted in the poor answering of Q3.2 (1 mark).

- (c) In Q3.5 (15 marks) most candidates attempted to draw the roof truss but the positioning of the wall plate, tie beam and ridge beam still posed a challenge to them.
- (d) Candidates struggled to draw to scale the components of a roof truss. Candidates did not adhere to 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 on the drawings.
- (b) More detailed presentations on the different parts of a staircase should be done to prepare learners to answer theoretical questions on staircases as well as the drawing thereof. Teachers should stress the difference between line diagrams and two- or three-dimensional drawings to learners.
- (c) It is recommended that teachers provide learners with more exercises on the drawing of roof trusses in order 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 Q4.1.4 (1 mark) candidates were not able to identify the depth of a trench for the non-bracing of trenches.
- (b) Many candidates could not differentiate between the poling boards for loose and firm soil in figures A and B in Q4.2.1 (2 marks) and Q4.2.2 (2 marks).
- (c) Poor performance was recorded for Q4.2.3 (2 marks) due to a lack of content knowledge in formwork. Most candidates were not able to differentiate between the spacing of poling boards for different soil types.
- (d) Most candidates were not able to explain what water-retaining material is in Q4.6 (1 mark).
- (e) In Q4.7 (18 marks) most candidates were not able to draw the formwork for a beam with an attached floor slab.

Suggestions for Improvement

- (a) Teachers should focus more on the topic of excavations in order for learners to have a more in-depth insight of the topic. Teachers should develop possible questions on excavations which will assist learners in understanding the content.

- (b) A distinction should be made between *poling boards* and *waling boards* with regard to their positions in loose and firm soils.
- (c) A model of the formwork for different types of soil structures will assist learners in gaining a better understanding of formwork for various soil types.
- (d) It will benefit learners if they are exposed to water-retaining materials that are used for curing concrete.
- (e) 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 5: PLASTER AND SCREED, BRICKWORK AND GRAPHICS AS MEANS OF COMMUNICATION

Common Errors and Misconceptions

- (a) In Q5.3 (1 mark) many candidates were not familiar with the properties of plaster.
- (b) In Q5.5.1 (4 marks) and Q5.5.2 (1 mark) many candidates had difficulty in identifying the different strata of a paved area and were not able to state why a paved area may collapse.
- (c) Most learners were not able to draw a course of the cavity wall correctly in Q5.6 (7 marks).
- (d) In Q5.7 (14 marks) only a few candidates drew the horizontal section through a window frame showing how it is attached to a wall. Many candidates could not differentiate between a horizontal and a vertical section and hence drew the wrong section.

Suggestions for Improvement

- (a) The properties of building materials is a critical aspect in the selection of the correct material to suit the purpose. More emphasis should be placed on the properties of building materials.
- (b) It would be beneficial to learners if they practically apply the process of paving.
- (c) Learners should 'dry-pack' a few consecutive courses of a cavity wall to enhance their understanding of the topic.
- (d) More emphasis should be placed on the difference between *horizontal* and *vertical* sectional views of parts of a building.

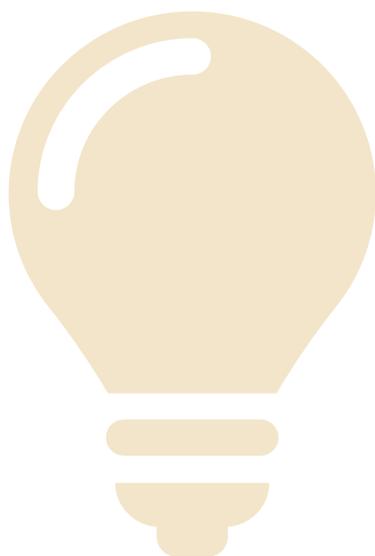
QUESTION 6: REINFORCEMENT IN CONCRETE, FOUNDATIONS, CONCRETE FLOOR AND QUANTITIES

Common Errors and Misconceptions

- (a) In Q6.4 (2 marks) the explanation of the installation process of in-situ driven piles (steel tube caisson piles and pre-cast concrete piles) posed a challenge to a significant number of candidates.
- (b) In Q6.5.2 (3 marks) candidates could not identify three factors to be considered after the casting of the concrete for a suspended floor.
- (c) In Q6.6 (11 marks) many candidates were not able to draw the reinforced concrete beam from the given specifications correctly and were not familiar with the correct names of the different members of the reinforcing.
- (d) Many candidates could not calculate the correct length of wall plates and the number of roof trusses in Q6.7 (10 marks).

Suggestions for Improvement

- (a) Models can be used during teaching to explain the differences between the installation processes of the different types of concrete piles. Video clips may also be used if models are not available.
- (b) The hydration process of concrete needs to be clearly explained to learners for them to properly understand the treatment of concrete after it has been cast.
- (c) 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 of that component.
- (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.



4.3 WOODWORKING

The following report should be read in conjunction with the Woodworking question paper of the November 2019 examinations.

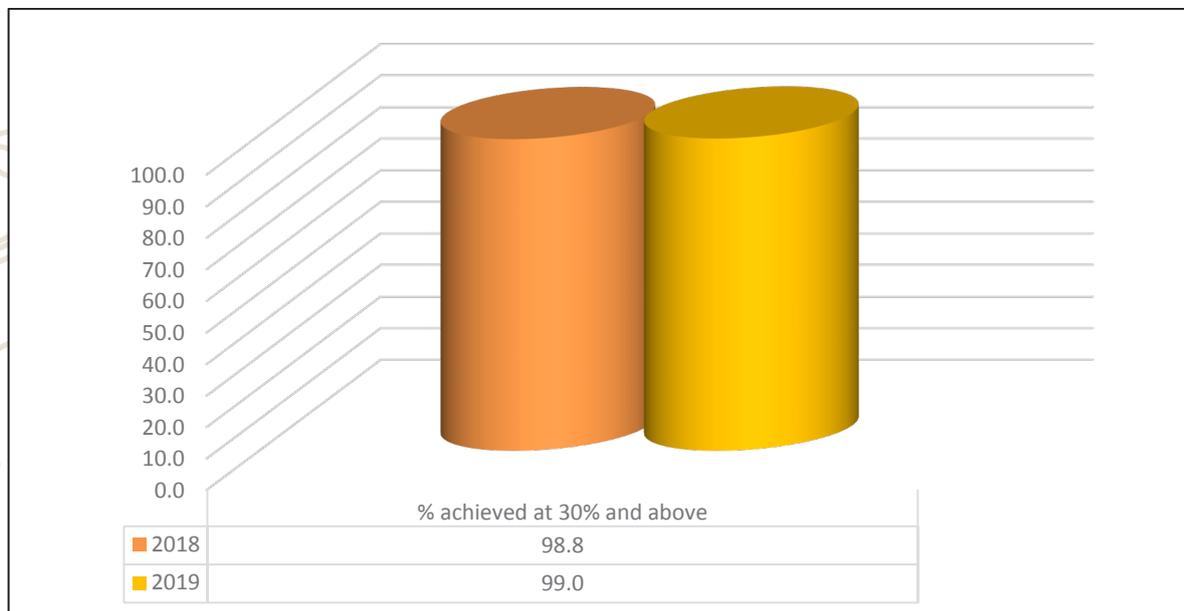
4.3.1 PERFORMANCE TRENDS (2019)

In 2019, 1 946 candidates sat for the Woodworking examination. The performance of the candidates in 2019 represents a slight improvement compared to the performance in 2018.

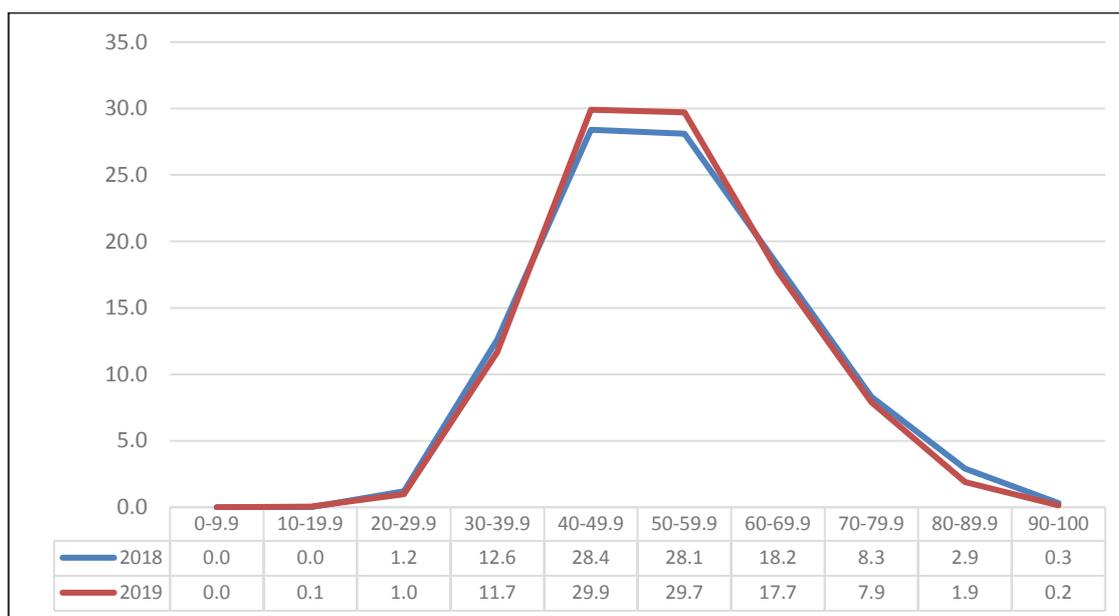
Table 4.3.1(a) Overall Achievement Rates in Woodworking

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

Graph 4.3.1 (a) Overall Achievement Rates in Woodworking (Percentage)



Graph 4.3.1 (b) Overall Achievement Rates in Woodworking (Percentage)



4.3.2 OVERVIEW OF LEARNER PERFORMANCE IN THE 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 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 sequence, e.g. *Explain how to use the multi-detector to locate objects inside a wall.*
- 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) Responses of candidates given to questions regarding safety and equipment, were mostly general responses that are incorrect, instead of specific responses, e.g. candidates responded by indicating that workers should wear PPE instead of a specific item, like a hard hat.
- (i) Many candidates found it difficult to explain practical applications theoretically.
- (j) It is recommended that learners study drawings by doing the drawing freehand until they know all the parts and the sequence to follow, before they start with scale drawings.
- (k) 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.
- (l) It is important that all topics be sufficiently covered before the preparatory examinations commence.
- (m) 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 at all cognitive levels.
- (n) Learners must be aware that if the unit is not stated in their answers, they may lose marks.

4.3.3 ANALYSIS OF LEARNER PERFORMANCE IN EACH QUESTION

QUESTION 1: OHS&A, MATERIALS, TOOLS, EQUIPMENT AND JOINING

Common Errors and Misconceptions

- (a) In Q1.1 (8 marks) candidates had difficulty matching the descriptions in the matching-items question with the items. Candidates had to demonstrate deeper insight in the properties and principles applied in materials and tools than the mere identification and use thereof and were not fully equipped to respond in the required manner.
- (b) In Q1.5 (2 marks) candidates responded poorly to the question relating to the transporting of material and gave general answers related to the handling of material instead.
- (c) In Q1.6 (1 mark) many candidates responded incorrectly to the safety requirements related to scaffold planks; instead they gave responses that were pertinent to scaffolding in general.
- (d) In Q1.8.1 (1 mark) many candidates described the *fastener* instead of *identifying* it.

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 the skill of using them. The challenges of answering this type of question can 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 needs to be responded to.
- (c) Teachers should divide topics with a long list of possible answers into smaller subsections and group the relevant answers with the subtopics during teaching. Learners should be taught how to interpret and respond to this type of question.
- (d) More emphasis should be placed on the use of the correct terminology when identifying objects. It is advisable that teachers focus strongly on the use of correct terminology during teaching or when marking class and homework of learners.

QUESTION 2: GRAPHICS AS METHOD OF COMMUNICATION

Common Errors and Misconceptions

- (a) Many candidates experienced challenges to read and interpret the floor plan and elevation and were not able to identify and interpret drawing symbols.
- (b) Poor performance by candidates was noted in Q2.2 (1 mark) where the identification of a hipped roof posed a challenge to them.
- (c) In Q2.5 (1 mark) most candidates identified the component as a door opening instead of a door.
- (d) In Q2.8 (1 mark) the majority of candidates were not able to identify the symbol of a wash trough.
- (e) Some candidates could not identify the drawing symbol in Q2.13 (1 mark).
- (f) In Q2.15 (1 mark) many candidates misinterpreted the question to name a material that should be used instead of a material that should *not* be used.
- (g) In Q2.16 (1 mark) the responses of candidates indicated that they were not familiar with the properties and uses of materials used for the production of sanitary fittings.
- (h) In Q2.27 (2 marks) a significant number of candidates could not identify the landing on the staircase and also misinterpreted the question. Instead of responding to the uses or functions of the indicated symbols on the drawing, candidates identified the symbols.
- (i) In Q2.28 (1 mark) the majority of candidates had difficulty in justifying why the floor plan was relevant to the elevation. This question required insight into the differences between a ground floor plan and that of the first floor.

- (j) In Q2.29 (1 mark) most candidates were unable to explain the consequences of not installing a sill below a window.
- (k) In Q2.31 (6 marks) many candidates could not correctly deduce the dimensions of the wall thickness and room sizes from the correct elevation. They also could not write them down next to one another and add the dimensions to obtain the total length of the wall correctly.

Suggestions for Improvement

- (a) Building plans should be used during teaching to familiarise learners in interpreting building plans.
- (b) Models of the profiles of the different types of roof layout should be made by learners to help them understand the shapes of the roofs when being viewed from the top, front and sides.
- (c) More analytical questions and worksheets, similar to Q2 in the question paper, should be done in class.
- (d) The *SANS Code of Practice for Drawing Symbols* should be used when teaching sections that require learners to draw or identify drawing symbols used in the building industry.
- (e) Teachers should develop worksheets comprising a schedule of all drawing symbols used in the drawing of floor plans for learners to complete.
- (f) A tour of the school would be beneficial to learners to show them the different materials that can be used as trimmings around a roof.
- (g) Samples of sanitary fittings must be made available to learners to aid them with identification and to familiarise them with the properties and uses.
- (h) Learners should draw floor plans with elevations so that they can identify the elevations relevant to the sides of a floor plan.
- (i) It is recommended that teachers use correct terminology during teaching, especially when referring to units, i.e. width, length and height.
- (j) It will be beneficial to learners if teachers use copies of building plans when teaching this topic. Specific reference should be made to the different items and symbols used on building plans. It is recommended that learners be taken on an excursion to view multi-storey buildings while the teacher explains the different facets of the buildings. These facets can then be linked to the symbols and parts of a building on the building plan. Photos and videos can be used to demonstrate the different parts of a building if an excursion is not viable.
- (k) Learners should be exposed to more calculations involving area, perimeter and lengths of walls to ensure that learners 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 identify the different parts of a vertical section through a transom and its adjacent casement and fanlight members.
- (b) In Q3.4 (5 marks) most candidates experienced challenges to calculate the area of a roof sheet and the number of ridge plates required. 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) 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.
- (c) More exercises on the calculation of quantities of materials should be given to the 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 (2 marks) many candidates could not identify the lathe and jigsaw.
- (b) In Q4.6 (2 marks) some candidates named a material instead of a part of the trap door.
- (c) Stating the size of roof truss members posed a challenge to the candidates in Q4.7 (2 marks).
- (d) In Q4.8 (2 marks) candidates could not state the use of hurricane clamps and storm clips.
- (e) In Q4.9 (20 marks) many candidates drew the wrong roof truss.

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) A model of a conventional and hinged trap door should be made to demonstrate to learners how the attic of a roof can be accessed via the trap doors.
- (c) Off-cuts from roof truss manufacturers should be obtained and learners should measure these to become familiar with their sizes.
- (d) Examples of different types of roof coverings should be made available and used during the teaching of these topics to show how the roof coverings are held in place under the eaves.
- (e) 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.

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

Common Errors and Misconceptions

- (a) Q5.1 (2 marks) posed a challenge to candidates who could not differentiate between the two types of laggings.
- (b) In Q5.2 (6 marks) many candidates did not draw the correct centre for a semi-circular arch with a small span.
- (c) In Q5.5 (8 marks) most candidates did not interpret the question correctly and drew the whole sectional view instead of just the left half of the formwork as required.
- (d) In Q5.6 (6 marks) some candidates were not able to identify the parts of a flying shore.
- (e) In Q5.7 (6 marks) poor performance was recorded in the drawing of the joint. From the candidates' responses, it was evident that they lacked practical exposure and experience.

Suggestions for Improvement

- (a) Part of a rib with laggings should be used during the presentation of lessons to show the difference between *closed laggings* and *open laggings*.
- (b) It is suggested that a centre for a door opening be made and erected within the reveals of the wall to show the props, beams and wedges.
- (c) A temporary flying shore should be erected in a passage. This will improve the understanding of the learners of the use and purpose of shoring.

- (d) A practical lesson on how to make a stub haunched mortice and tenon joint should be demonstrated.
- (e) A model can also be used as a teaching aid for the drawing of joints.
- (f) Teachers should emphasise to learners that reading the question properly before attempting to answer the question is essential.

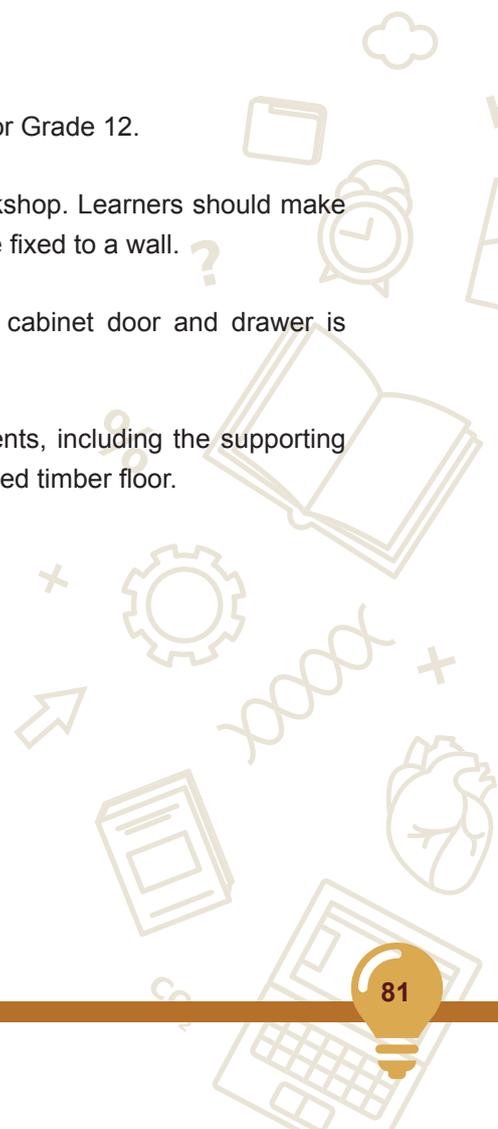
QUESTION 6: SUSPENDED FLOORS, STAIRCASES, IRONMONGERY, DOORS AND JOINING

Common Errors and Misconceptions

- (a) In Q6.2 (2 marks) only a few candidates could state the correct name of the timber joint.
- (b) In Q6.3 (6 marks) most candidates could not draw the sectional views of a door frame and jamb lining to show the difference of their profiles.
- (c) In Q6.5 (2 marks) many candidates could not specify the two instances where the straight cupboard lock could be used.
- (d) In Q6.8 (12 marks) most candidates drew the suspended timber floor construction directly onto the ground.

Suggestions for Improvement

- (a) It would benefit learners to make the joints as prescribed in the *CAPS* for Grade 12.
- (b) A model of a door frame and a jamb lining should be made in the workshop. Learners should make drawings of these to understand the different shapes and how these are fixed to a wall.
- (c) A practical demonstration on the fitting of a cut cupboard lock to a cabinet door and drawer is recommended.
- (c) The use of a model of a suspended timber floor showing all components, including the supporting piers, will assist learners in gaining a better understanding of a suspended timber floor.



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 2019 examinations.

5.1.1 PERFORMANCE TRENDS (2018–2019)

This was the second time that this subject was offered as an NSC examination subject. In 2019, 323 candidates sat for the Digital Electronics examination, i.e. a decline of 84 in comparison to the previous year. The results reflect an improvement in the pass rate at the 30% level to 96%. A particularly pleasing trend was that 41,5% of candidates achieved over 50% this year in comparison to 28,2% of candidates doing so in 2018.

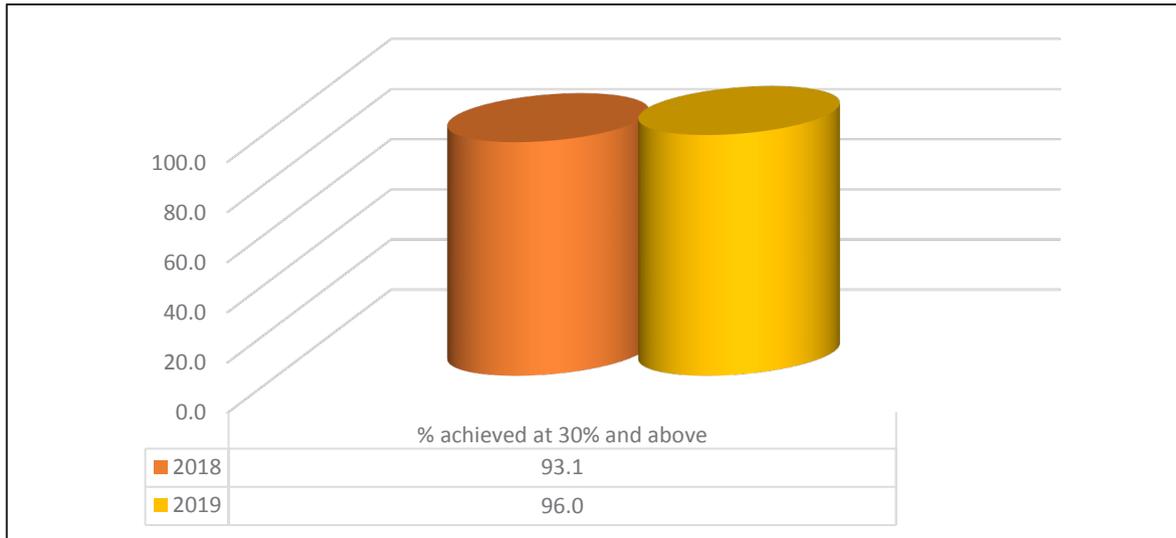
Table 5.1.1(a) Overall Achievement Rates in Electrical Technology – Digital Electronics

Year	No. Wrote	No. achieved at 30% and above	% achieved at 30% and above
2018	407	379	93,1
2019	323	310	96,0

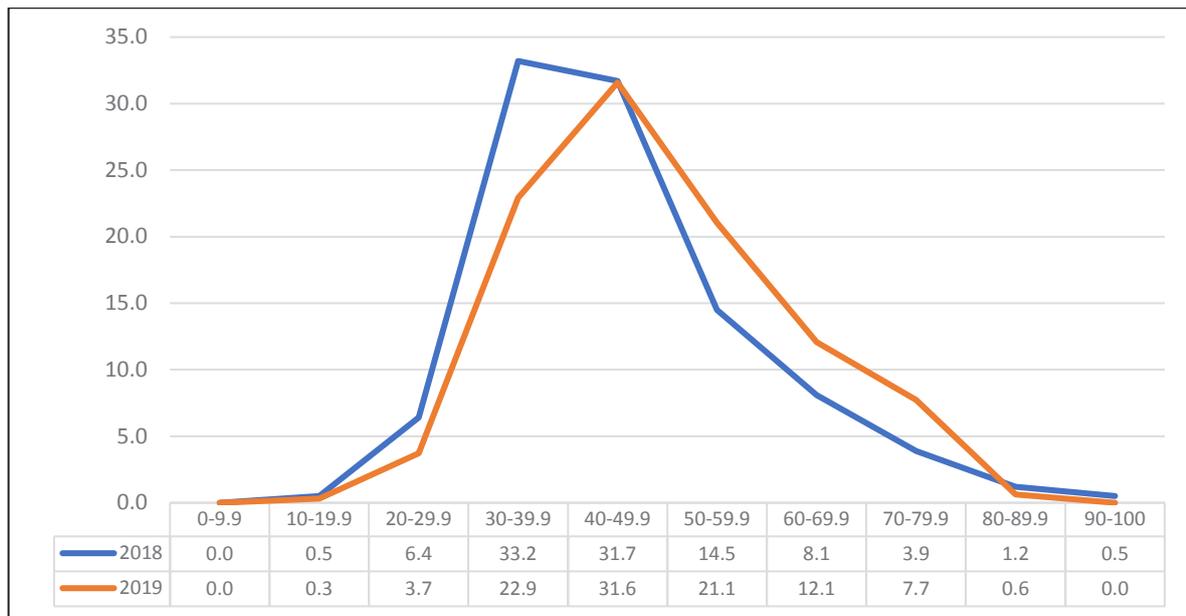
Further improved performance can be achieved if there is a strengthening of content knowledge in respect of switching circuits, digital and sequential devices and microcontrollers. In addition, learners should have practical exposure to these areas. They also need to be exposed to complex questions and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



Graph 5.1.1 (a) Overall Achievement Rates in Electrical Technology – Digital (Percentage)



Graph 5.1.1 (b) Performance Distribution Curves in Electrical Technology – Digital (Percentage)



5.1.2 OVERVIEW OF LEARNER PERFORMANCE IN DIGITAL ELECTRONICS

General Comments

- (a) Poor performance was recorded even in the questions that were set at the lower cognitive levels.
- (b) Candidates could not interpret the requirements of the questions due to their poor language comprehension skills.
- (c) It is evident that many candidates lacked the proper content knowledge and the necessary skills to answer the questions.
- (d) Many candidates had difficulty answering questions of a narrative nature.
- (e) The question that requires learners to explain basic operations of circuits is still a challenge because of a lack of knowledge and insight in the 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 well presented and there was a great improvement in the correlation between the input and output waveforms.

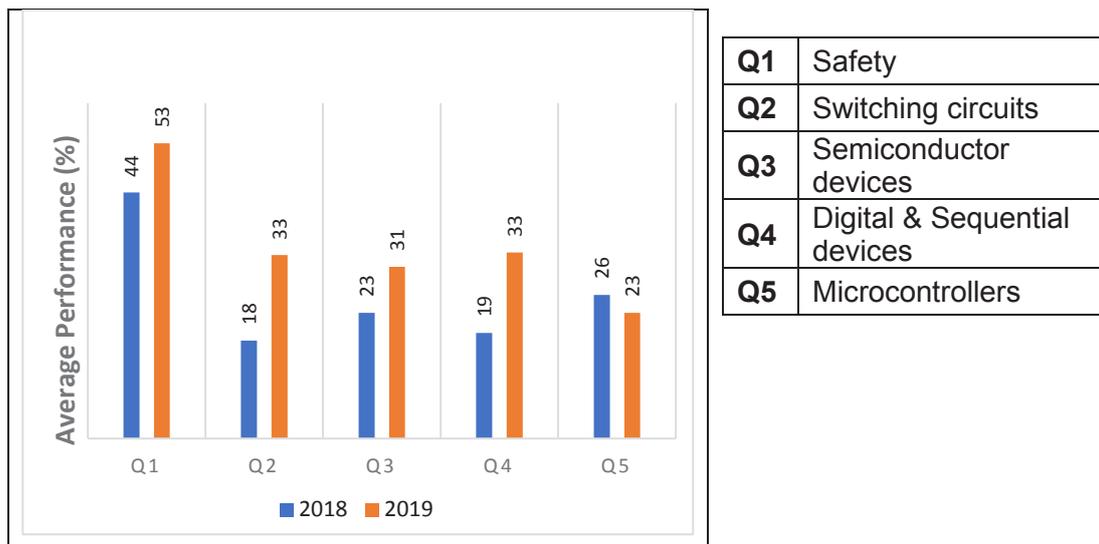
General Suggestions for Improvement

- (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 must be used for revision purposes only. Past papers cannot replace the *CAPS* document. Every learner must have access to past examination papers. Papers such as the 2018 exemplar, November 2018/19 and the May/June 2019/20 supplementary paper 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 switching circuits, digital and sequential devices and microcontrollers, as this is stipulated for Grade 12 in the *CAPS*.
- (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 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 past papers to develop the skills necessary to interpret the requirements 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 (a) Average Marks per Question Expressed as a Percentage



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 have lacked basic knowledge of the content and therefore could not answer the questions.

5.1.4 ANALYSIS OF LEARNER PERFORMANCE IN INDIVIDUAL QUESTIONS

QUESTION 1: OCCUPATIONAL HEALTH AND SAFETY

Common Errors and Misconceptions

- In Q1.1 candidates used general explanations instead of answering the specific requirements of the question.
- Most candidates could not interpret the words *protect* and *provide* in Q1.2.
- In Q1.3 candidates responded incorrectly according to the school environment rather than referring to the industrial environment/OHS context.
- The definition of the term *workplace* in Q1.2.2 often lacked mention of the phrase 'during his time of employment'.

Suggestions for Improvement

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.

QUESTION 2: SWITCHING CIRCUITS

Common Errors and Misconceptions

- (a) In Q2.2.2 most candidates could not analyse the circuit and described what will occur if threshold pin 6 was purposely held low.
- (b) The circuit diagram in Q2.3.2 was partly drawn and not fully labelled.
- (c) In Q2.4.1 most candidates could not identify the op amp circuit correctly and could not explain how the reference voltage could be made negative.
- (d) In Q2.5.1 candidates had difficulty in explaining how the gain of the inverting summing amplifier can be determined.
- (e) In the calculation of gain in Q2.5.4, candidates left out the prefixes of the unit in the substitution stage. The calculation of this question was done well and the gain was given in units when this was not required.
- (f) In the calculations for Q2.5.2 most learners could not substitute $V_1 = 300 \text{ mV}$, $V_2 = 500 \text{ mV}$ and $V_3 = 400 \text{ mV}$ correctly. They omitted the milli- (10^{-3}).
- (g) In Q2.5.5 candidates could not explain the advantages of using a variable resistor instead of a fixed one.
- (h) There was an improvement in learner responses to questions requiring the drawing of output waveforms. However, Q2.6.2 and Q2.7.3 was poorly answered. Candidates' responses show that they have insufficient knowledge on these concepts.
- (i) In Q2.5.6 the candidates had little understanding of circuit dynamics. When values of components were changed, they lacked the comprehension to explain this specifically.
- (j) Most candidates named the key operating point as $+V$ and $-V$, I_{in} and V_{out} in Q2.7.2.

Suggestions for Improvement

- (a) The content gaps, coupled with the apparent lack of training of teachers, contributed to the poor learner performance. It is vital to provide formal training to teachers on this topic.

- (b) Scientific notations/prefixes should be integrated, e.g. kilo-- (1 000) and milli-- (0.003). Refer to page 112 in the Grade 10 prescribed textbook.
- (c) Candidates need more exposure to the simulations that can be used to enhance learning and conceptual understanding of the curriculum.

QUESTION 3: SEMICONDUCTOR DEVICES

Common Errors and Misconceptions

- (a) In Q3.1.1 candidates failed to identify 'PIN 1' and were not able to provide a clear description.
- (b) In Q.3.1.2 the stages of the internal circuit of the op amp were not known by many candidates. The reasons for negative feedback for the linear operation of the op amp was not understood by most candidates.
- (c) Candidates wrote only +15 V and not +15 V and -15 V for Q3.2.3.

Suggestions for Improvement

Teachers should place additional focus on the following issues when revising this section of content with learners:

- 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

QUESTION 4: DIGITAL AND SEQUENTIAL DEVICES

Common Errors and Misconceptions

- (a) Candidates could not draw the circuit diagram required in Q4.2.1.
- (b) Most candidates did not provide the appropriate output logic levels in the truth tables in Q4.2.2, Q4.3.3, Q4.4.2 and Q4.5.2.
- (c) In Q4.3.2 the candidates could not fully explain the function of the transistor drivers.
- (d) In Q4.5.2 the truth table was incorrectly completed, and most candidates used an example from the prescribed textbook which was incorrect.
- (e) Candidates gave types of counters instead of applications of counters in Q4.6.

- (f) In Q4.7 some candidates were not able to draw circuit logic diagrams for the decoder and RS flip-flop.
- (g) The register in Q4.8.1 was not correctly identified and candidates did not describe how data was introduced into and shifted out of the registers. The uses of registers were also not known.
- (h) Many candidates did not know how to draw the half-adder using gates, and many drawings were not labelled. The drawings given were untidy and did not use the EGD approach. The operation of the four-stage asynchronous binary to BCD counter was not answered by most candidates.
- (i) More practical and written work should be undertaken on analogue to digital converters and digital to analogue converters.

Suggestions for Improvement

- (a) More simulations should be done on all circuits where possible.
- (b) Adders should also be done practically.

QUESTION 5: MICROCONTROLLERS

Common Errors and Misconceptions

- (a) The definition of microcontrollers was vague and incomplete.
- (b) Many candidates did not describe the functions of microcontrollers, analogue to digital converter and 'CIR' adequately.
- (c) In Q5.4.1 the methods for sending data was not known by most candidates. The question on the I²C bus was poorly answered and the function of 'pull up resistors' was not known. Candidates did not know the RS232 communication protocol operating voltages and its application.
- (d) In the design of the flow diagram section, many candidates confused the symbols and did not label them. Many drew the arrows in the wrong direction or left them out.

Suggestions for Improvement

- (a) It is suggested that most of the questions be based on PICAXE and that the questions should take the approach of CAT (Computer Applications Technology). This is more hands-on and will generate interest in learners, thus yielding an improvement in learner performance. As with the leading nations in the world, the focus in basic technical education should be on practical work so that when candidates enter tertiary education, they have a well-developed sense of imagination regarding the abstract concepts that they are learning.
- (b) The following areas should be thoroughly taught with experiments where relevant:
 - Peripherals and protocols
 - Comparisons of buses
 - PICAXE diagrams and symbol commands
 - Timers and registers.

5.2 ELECTRONICS

The following report should be read in conjunction with the Electronics question paper of the November 2019 examinations.

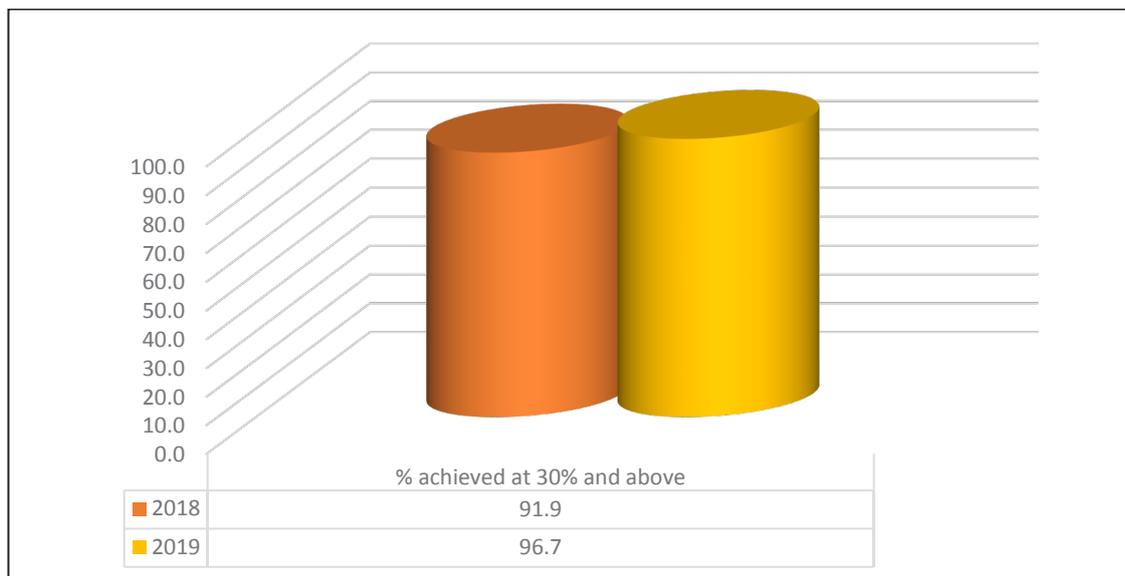
5.2.1 PERFORMANCE TRENDS (2018–2019)

This was the second time that this subject was offered as an NSC examination subject. In 2019, 938 candidates sat for the Electronics examination, i.e. a decline of 139 in comparison to the previous year. The results reflect an improvement in the pass rate at the 30% level to 96,7%. A particularly pleasing trend was that 39,8% of candidates achieved over 50% this year in comparison to 21,8% of candidates doing so in 2018.

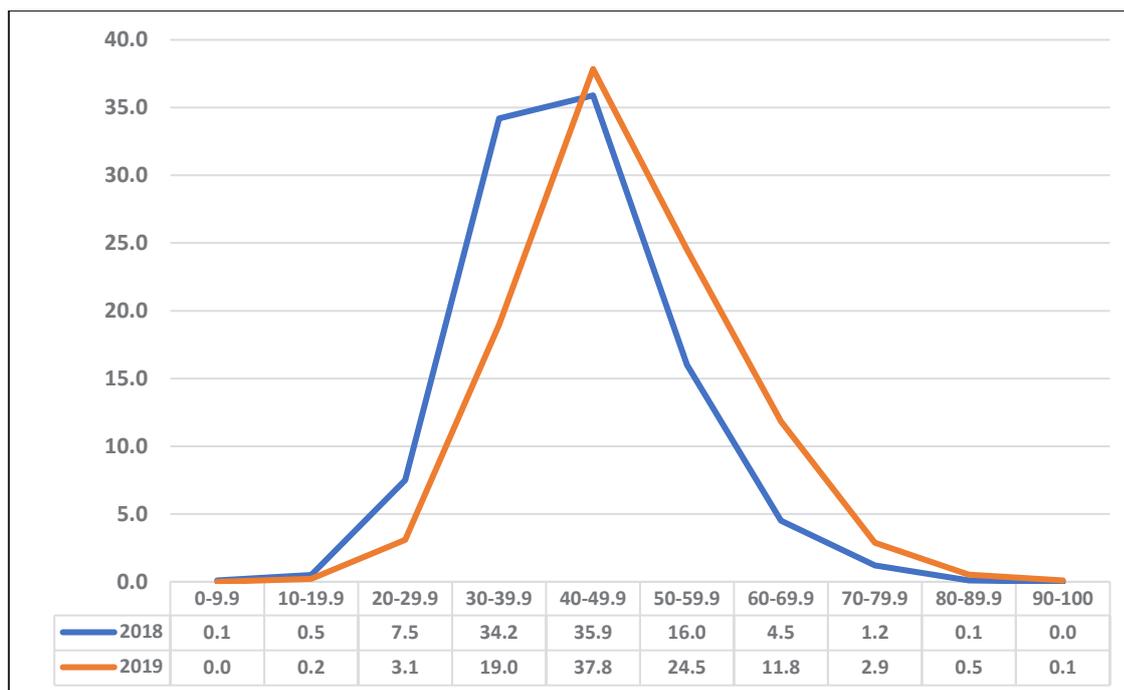
Table 5.2.1(a) Overall Achievement Rates in Electrical Technology – Electronics

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

Graph 5.2.1(a) Overall Achievement Rate in Electronics (Percentage)



Graph 5.2.2 (b) Performance Distribution Curve in Electronics (Percentage)



5.2.2 OVERVIEW OF LEARNER PERFORMANCE IN PAPER 1

General Comments

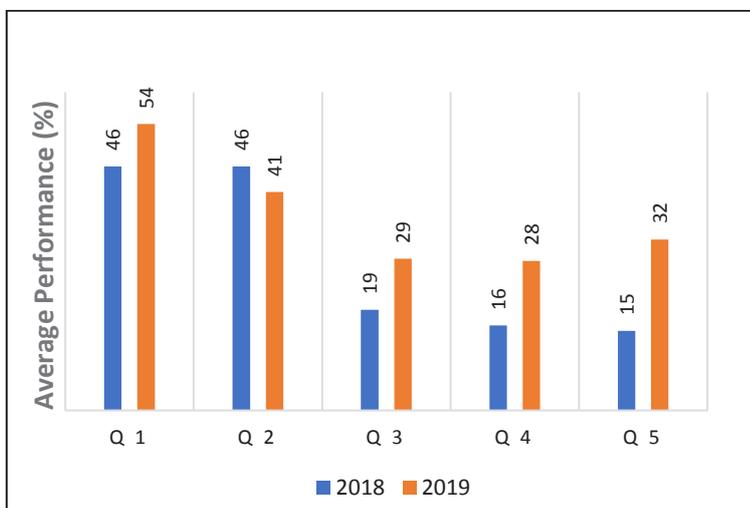
- (a) In general, the overall performance of candidates in the paper was very poor.
- (b) Q1 and Q2 were well answered but these questions comprised only 25% of the entire paper.
- (c) Q3, Q4 and Q5 were poorly answered. These questions comprised 75% of the total.
- (d) Candidates' language use was very 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.
- (e) It is evident that many candidates lack proper content knowledge and the necessary skills to answer the questions.
- (f) Many candidates struggled to answer questions of a narrative nature.
- (g) Manipulation of formulae in calculations is a challenge for candidates. Both the application of mathematic principles and expression of responses require further attention.
- (h) Marks were lost for the omission of units in the calculations and/or for wrong substitution and the omission of labels in the drawings.
- (i) The huge volume of circuit diagrams, output waveforms and characteristic curves is a challenge for most students.

- (j) 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.

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 5.2.3.1 Average marks per question expressed as a Percentage



Q1	Occupational Health and Safety
Q2	RLC Circuits
Q3	Semi-Conductor Devices
Q4	Switching Circuits
Q5	Amplifiers

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

5.2.4 ANALYSIS OF LEARNER PERFORMANCE THE QUESTION PAPER.

QUESTION 1: OCCUPATIONAL HEALTH AND SAFETY

Common Errors and Misconceptions

- In Q1.1 candidates used general explanations instead of answering the specific requirements of the question.
- Most candidates could not interpret the words *protect* and *provide* in Q1.2.
- In Q1.3 candidates responded incorrectly according to the school environment rather than referring to the industrial environment/OHS context.

- (d) The definition of the term *workplace* in Q1.2.2 often lacked mention of the phrase ‘during his time of employment’.

Suggestions for Improvement

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.

QUESTION 2: RLC CIRCUITS

Common Errors and Misconceptions

- (a) In Q2.1.1 and Q2.1.2 many candidates did not define the *power factor* and *the quality factor* as a ratio.
- (b) The applications of ‘RLC’ circuits were not known. In Q2.3.1 and Q2.3.2 candidates used incorrect units and the wrong formula to calculate the inductive reactance.
- (c) Candidates could not draw the phasor diagram for Q2.3.4 correctly. Those who did draw the diagram correctly, failed to label it fully.
- (d) In Q2.3.5 candidates could not describe the effect of an increase in impedance on the phase angle while keeping the resistance constant.
- (e) Candidates could not do the conversion from power factor to phase angle in Q2.4.2.
- (f) In Q2.4.3 with the concept of leading and lagging, candidates referred to just voltage and current instead of ‘supply’ voltage and ‘supply’ current.
- (g) The majority of candidates could not calculate the capacitor value in Q2.5.1. They also used the wrong unit.
- (h) In Q2.5 candidates did not detect that the circuit was at resonance and hence calculations were done without taking this into account. The concept of resonance in this question was not understood, since candidates could not equate X_L to X_C . This question was poorly answered because learners did not fully understand the concept of RLC in an AC circuit.

Suggestions for Improvement

- (a) All calculations must have the correct formula, correct substitution, and an answer with the applicable unit.
- (b) The selection and use of the correct formula should also be a part of everyday teaching. More time should be allocated for working through examples using past exam papers.
- (c) More emphasis should be placed on phasor diagrams. All labels, arrows and the angle must always be given.

- (d) The practical building of RLC circuits and the checking of the waveforms on the oscilloscope is a good way to reinforce the theory. In addition, learners must use the same calculator often to familiarise themselves with its operation/working.
- (e) Higher order understanding of application of circuits and concepts must be revised regularly.

QUESTION 3: SEMICONDUCTOR DEVICES

Common Errors and Misconceptions

- (a) In Q3.3.2 most candidates could not list the biasing of a field effect transistor correctly . The triggering of the UJT in Q3.4.2 was also a challenge for many candidates.
- (b) In Q3.4.3 most candidates redrew the given waveforms which were provided on the attached answer sheet.
- (c) Most candidates could not identify PIN1 in Q3.5.1.
- (d) Most candidates did not know the stages of the internal circuit of the op amp in Q3.5.2.
- (e) In Q3.7.1 most candidates did not know the type of 'DIP package' for the 741 op amp.
- (f) Reading information from a data sheet was a challenge for most candidates. They could not identify the trigger points in Q3.7.3.
- (g) Explaining what would happen to the output of the 555 IC in Q3.8 was a challenge for most candidates.

Suggestions for Improvement

- (a) Circuit diagram analysis as well as drawing of input and output waveforms must be emphasised.
- (b) Learners need more exposure to 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.
- (c) Electrical Technology is an applied subject and therefore the explanation of circuits must be coupled with calculations as well as input and the correlating output waveforms. The changing of components affects the characteristics and the operating point of the circuit. This should direct the teachers' approach and style when covering this subject.
- (d) On the introduction of each component, learners should be given assignments on the construction of components, their symbols and their operation.
- (e) Teachers should introduce learners to:
 - Datasheets for different components
 - Analytical fault-finding scenarios, both theory and practical

- (f) Teachers are advised to make a summary of different components and circuits with characteristics and operating principles and provide this to learners for revision. Learners must be encouraged to draw characteristic curves of components and circuits.
- (g) Teachers must include the characteristic curves in their explanations of the working principles and operating voltages of all components.
- (h) During the explanation of circuits, the use of the correct formulae in the calculations should be emphasised.
- (i) Teachers must ensure that learners always use the units correctly. An answer without a unit is not valid and a mark is lost even when the calculated answer is correct.

QUESTION 4: SWITCHING CIRCUITS

Common Errors and Misconceptions

- (a) In Q4.1 candidates could not identify the multivibrator when a block diagram was used instead of a circuit diagram.
- (b) Candidates did not provide the function of the pull-up resistors in Q4.2.1.
- (c) In Q4.2.2 the voltage drop across R1 and R2 was incorrectly answered. The candidates knew that once trigger pin 2 goes low, the device will change state but the effect that this will have on the LED was not answered.
- (d) Candidates could not analyse the circuit in Q4.2.3 and describe what will occur if threshold pin 6 was purposely held low.
- (e) In Q4.3.2 the circuit diagram was partly drawn and labelling was left out in specific areas.
- (f) Many candidates could not identify the op amp circuit in Q4.4.1 correctly and explain how the reference voltage can be made negative.
- (g) In the calculation of gain in Q4.5.1, candidates left out the prefixes of the unit in the substitution stage. The calculation of this question was not well answered and the gain was given in units when this was not required.
- (h) Candidates could not explain the advantages of using a variable resistor instead of a fixed resistor in Q4.5.5.
- (i) The majority of the candidates could not answer Q4.5.6. Based on the responses it is evident that they had little understanding of the circuit dynamics.
- (j) Generally, there is a lack of understanding on the working principles of switching circuits.

Suggestions for Improvement

- (a) Learners need more exposure to simulations to enhance learning and conceptual understanding of the curriculum. Electrical Technology is an applied subject and therefore it is good practice to consolidate the theory with some practical simulations, experiments and demonstrations.
- (b) The changing of component values affects the characteristics and the operating point of a circuit. This should be shown and explained by the teacher during practical sessions.
- (c) 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 the 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.
- (d) Teachers must emphasise the following:
- The integration of EGD and Electronics when drawing the output waveforms
 - Correct labelling of all diagrams
 - Use of the answer sheet from the final examination as a guide when assessment tasks are developed
 - Use of the correct prefixes in all calculations and showing them in the substitution.
- (e) Teachers should ensure that:
- Regular informal tests are written to consolidate work done
 - Multivibrator circuits using both operational amplifiers and timers are covered theoretically and practically according to the CAPS.
- (f) Teachers can assist learners in summarising the circuits with relevant input and output waveforms and operation.

QUESTION 5: AMPLIFIERS

Common Errors and Misconceptions

- (a) In Q5.1 candidates were challenged by the following:
- Comparison of class 'A' and 'B' and the efficiency of each
 - The purpose of the components of the amplifier circuits
 - The operation of the amplifier circuits.
- (b) The question on the purpose of the resistors in the circuit of Q5.2.1 received vague responses.
- (c) In Q5.2.2 candidates did not understand the dynamic operation and explanation of the drops in voltage when the transistor operates.
- (d) The concept of *biasing* in Q5.3 was incorrectly answered.

- (e) Many candidates did not know where the input and output signals were to be found in Q5.6.2.
- (f) Candidates did not interpret the circuit in Q5.6.3 correctly and hence all follow-up questions were answered incorrectly.
- (g) In Q5.7 the methods used in the coupling of amplifiers were not well presented.
- (h) Many candidates used the correct formula and substitution in Q5.8.1 and Q5.8.2 but got the answer wrong. The voltage gain calculation was done incorrectly due to incorrect substitution.
- (i) It was evident from the responses in Q5.11 that many candidates were not familiar with the complementary symmetry push-pull amplifier and its operation, characteristics and output waveform.
- (j) In Q5.12 many candidates could not differentiate between *RC* and *LC* oscillators with reference to feedback and oscillation frequency.

Suggestions for Improvement

- (a) Teachers are advised to focus on the following:
 - Calculation processes
 - Input and output waveforms of amplifiers
 - Transistor characteristics including drawing of the load line on the graph
 - How the biasing of a transistor and the different values of R_B will determine the Q-point of the transistor on the load line
 - The function of all components in a circuit diagram.
- (b) Teachers must clearly explain the purpose of the feedback circuit and the amplifier circuit in an oscillator, e.g. LC oscillator and RC oscillator circuits.
- (c) Content coverage and mastery with regular informal assessment activities on theory and drawing of circuits using an Engineering Graphics and Design (EGD) approach will benefit learners' understanding.
- (d) Consolidating all amplifier circuits by building the circuits practically would lead to better understanding.
- (e) Learners need more exposure to the simulations that can be used to enhance learning and conceptual understanding of the curriculum.

5.3 POWER SYSTEMS

This report should be read in conjunction with the Power Systems question paper and Marking Guidelines of the November 2019 examinations.

5.3.1 PERFORMANCE TRENDS (2018–2019)

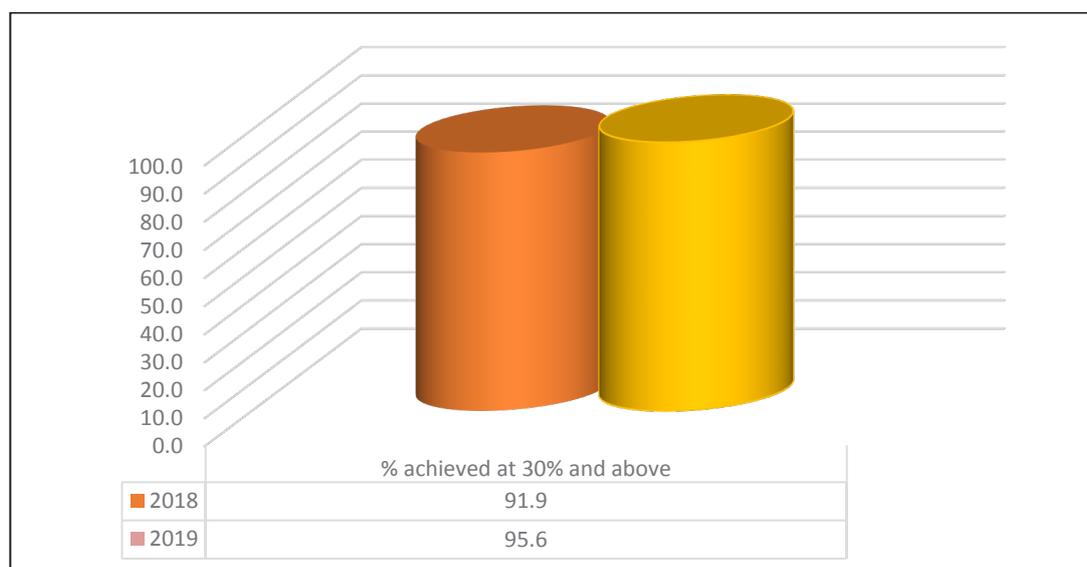
This was the second time that this subject was offered as an NSC examination subject. In 2019, 4 796 candidates sat for the Power Systems examination, i.e. a decline of 432 in comparison to the previous year. The results reflect an improvement in the pass rate at the 30% level to 95,6%. A particularly pleasing trend was that 43,6% of candidates achieved over 50% this year in comparison to 33,0% of candidates doing so in 2018.

Table 5.3.1(a) Overall Achievement Rates in Electrical Technology (Power System)

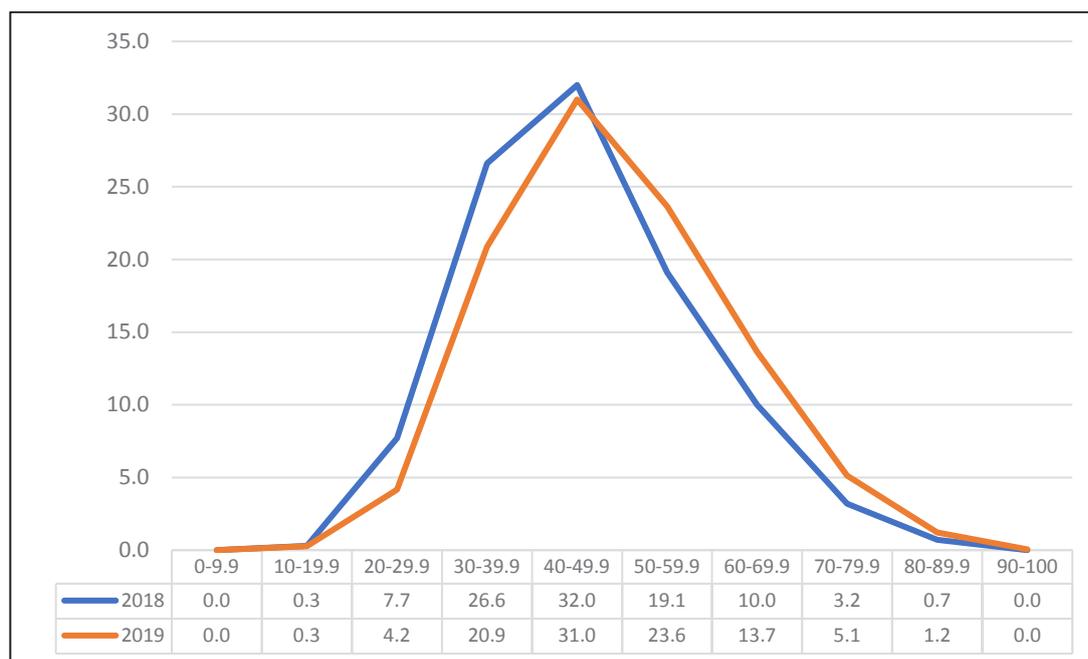
Year	No. Wrote	No. achieved at 30% and above	% achieved at 30% and above
2018	5 228	4 806	91,9
2019	4 796	4 583	95,6

The performance of candidates in 2019 can be attributed to stability in the curriculum and that teachers and learners are becoming familiar with the assessment style of the subject. However, 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

General Comments

- (a) Based on the candidates' responses it is evident that most candidates:
- Are still experiencing challenges with the interpretation of the requirements of the question
 - Had 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 knowledge and insight into the concepts.
- (c) The application of mathematical principles and the expression of responses after analysing circuits require further attention.

General suggestions for improvement

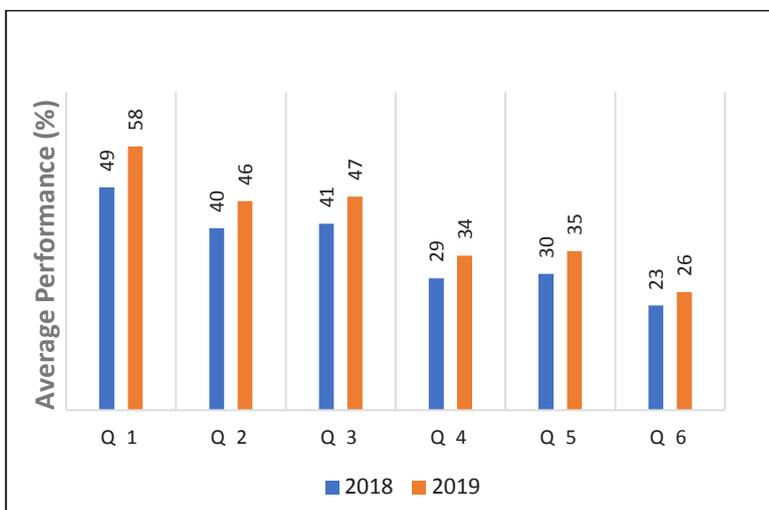
- (a) **Use of Past NSC Papers:** It must be noted that past question papers serves as one of many teaching and learning resources. These papers must be used for revision purposes only. Past papers cannot replace the CAPS document. Every learner must have access to past examination papers such as the 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 in the question paper.
- (d) **Practical Experiments and Past Papers:** Teachers must carry out informal practicals with learners as this is required for better performance in Q2, Q4, Q5 and Q6.

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 5.3.3.1 Average Marks per Question Expressed as a Percentage



Q1	Occupational Health and Safety
Q2	RLC Circuits
Q3	Three-phase AC generation
Q4	Three-phase transformer
Q5	Three-phase motors & starters
Q6	Programmable logic controllers

QUESTION 1: OCCUPATIONAL HEALTH AND SAFETY

Common Errors and Misconceptions

- (a) In Q1.1 candidates used general explanations instead of answering the specific requirements of the question.
- (b) Most candidates could not interpret the words *protect* and *provide* in Q1.2.
- (c) In Q1.3 candidates responded incorrectly according to the school environment rather than referring to the industrial environment/OHS context.
- (d) The definition of the term *workplace* in Q1.2.2 often lacked mention of the phrase 'during his time of employment'.

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.

QUESTION 2: RLC CIRCUITS

Common Errors and Misconceptions

- (a) In Q2.1.1 and Q2.1.2 many candidates did not define the *power factor* and the *quality factor* as a ratio.
- (b) The applications of 'RLC' circuits were not known. In Q2.3.1 and Q2.3.2 candidates used incorrect units and the wrong formula to calculate the inductive reactance.
- (c) Candidates could not draw the phasor diagram for Q2.3.4 correctly. Those who did draw the diagram correctly, failed to label it fully.
- (d) In Q2.3.5 candidates could not describe the effect of an increase in impedance on the phase angle while keeping the resistance constant.
- (e) Candidates could not do the conversion from power factor to phase angle in Q2.4.2.
- (f) In Q2.4.3 in respect of the concept of leading and lagging, candidates referred to just voltage and current instead of 'supply' voltage and 'supply' current.
- (g) The majority of candidates could not calculate the capacitor value in Q2.5.1. They also used the wrong unit.
- (h) In Q2.5 candidates did not detect that the circuit was at resonance and hence calculations were done without taking this into account. The concept of resonance in this question was not understood, since candidates could not equate X_L to X_C . This question was poorly answered because learners did not fully understand the concept of RLC in an AC circuit.

Suggestions for Improvement

- (a) All calculations must have the correct formula, correct substitution, and an answer with the applicable unit.
- (b) The selection and use of the correct formula should also be a part of everyday teaching. More time should be allocated for working through examples using past exam papers.
- (c) More emphasis should be placed on phasor diagrams. All labels, arrows and the angle must always be given.
- (d) The practical building of RLC circuits and the checking of the waveforms on the oscilloscope is a good way of reinforcing the theory. In addition, learners must use the same calculator often to familiarise themselves with the workings of it.
- (e) Higher order understanding of application of circuits and concepts must be revised regularly.

QUESTION 3: THREE-PHASE AC GENERATION

Common Errors and Misconceptions

- (a) In Q3.1 most candidates mentioned the advantage of power factor improvement to suppliers and consumers, instead of to consumers only.
- (b) Most candidates could not answer Q3.2.
- (c) In Q3.3 most candidates could not differentiate between the *wattmeter* and the *kilowatt meter*.
- (d) Most candidates did not know the purpose of the national power grid and the control centre in Q3.4.
- (e) In Q3.5.1 the naming of the waveform according to the universally adopted sequence was a challenge to most candidates. They knew the colours of the three phases but could not present it in the correct sequence.
- (f) Most candidates substituted the output power instead of the input power in Q3.6.2.
- (g) In Q3.6.3 candidates could not equate phase current to line current, instead they recalculated the value of the phase current.
- (h) In Q3.7.1 most candidates could not substitute correctly. In the following calculation:

$$\begin{array}{ll} \text{They wrote } P = 14 + 18 \text{ instead of} & P = 14\,000 + 18\,000 \\ & = 32 \text{ kW} \end{array}$$

NOTE: 1 000, 10^3 or 'k' represents a number and not a unit and should therefore be written in all calculations.

- (i) In Q3.7.2 most candidates lost marks for not including the prefixes in their calculations.
- (j) Many candidates did not finish the calculation in Q3.7.3.

Suggestions for Improvement

- (a) Teachers should explain the following concepts and the relevant formulae:
 - True power
 - Apparent power
 - Reactive power
 - Power factor by using an analogue.
- (b) Teachers should emphasise:
 - The difference between input power and apparent power
 - Reasons why transmission and distribution of electricity is done in delta and star.

QUESTION 4: THREE-PHASE TRANSFORMER

Common Errors and Misconceptions

- (a) In Q4.1 most candidates provided both external factors and internal factors instead of external factors only.
- (b) In Q4.2 most candidates provided answers for a fault in a transformer and not an earth fault.
- (c) In Q4.3 most candidates provided cooling methods for a transformer in general and not specifically for a dry transformer.
- (d) Candidates seemed not to understand the operation of the transformer even though the basic principle of electromagnetism is done in Grade 10.
- (e) In Q4.6 many candidates could not describe the construction of the three-phase core type transformer.
- (f) In Q4.7.1 candidates could not finish up to the ratio level and left the answer as 7,5 instead of 7,5 : 1

- (g) In Q4.7.2 candidates confused the formula: $\frac{N_1}{N_2} = \frac{V_1}{V_2} = \frac{I_2}{I_1}$. They incorrectly swapped the numbers for primary or secondary winding, voltage and current.

Suggestions for Improvement

- (a) Learners must understand the relationship between *phase* and *line voltages/currents* in a star and delta connection.
- (b) Learners must know how core and shell type transformers are constructed.
- (c) Teachers should revise the following topics done in Grade 10 and 11 as an introduction to transformers in Grade 12: Electromagnetism, Magnetic Induction, Lenz's Law, Self and Mutual Induction and Faraday's law. This will assist in the understanding of the principle of the operation of the transformer.

QUESTION 5: THREE-PHASE MOTORS AND STARTERS

Common Errors and Misconceptions

- (a) In Q5.1 most candidates wrote on both mechanical and electrical inspection responses instead of electrical inspection responses only. The table on page 148 of the prescribed textbook is for commissioning a new motor and not for inspection/testing.
- (b) Most candidates could not describe why protective devices are necessary in the control circuit of motors in Q5.2.

- (c) In Q5.3.2 candidates explained the operation of the circuit instead of describing what would happen to contactor MC_1 if contact MC_1N/O_1 was faulty and permanently closed.
- (d) In Q5.3.3 many candidates could not explain the chronological operation of the control circuit. It must be noted that the MC_1 (contactor) must be energised first before $MC_1(N/O_1)$ or $MC_1(N/O_2)$ is activated.
- (e) Most candidates could not describe the function of the contactor MC_1 in Q5.3.4.
- (f) In Q5.4 most candidates could not explain why the starting current is reduced in a star-delta starter.
- (g) Some of the candidates could not calculate the pole pairs per phase from the total number of poles given in Q5.5.2.

Suggestions for Improvement

- (a) Further attention should be devoted to identification of the control circuit, components and their functions in the circuit.
- (b) Learners must know:
 - The operation of each starter
 - How to carry out motor inspections and testing
 - How to create faults in control circuits to test fault-finding skills

QUESTION 6: PROGRAMMABLE LOGIC CONTROLLERS (PLCs)

Common Errors and Misconceptions

- (a) In Q6.1.2 many candidates provided responses with reference to general safety and not with PLCs.
- (b) In Q6.3.3 most candidates replaced the hard-wired inputs and outputs symbols with the ladder logic symbols.
- (c) In Q6.4.2 most candidates listed types of sensors in the same category instead of naming sensors in different categories.
- (d) Candidates analysed the ladder logic diagram in isolation to the input and output pulses in Q6.6.1.
- (e) In Q6.6.2 many candidates could not identify whether the circuit was an OFF Delay or an ON Delay circuit.
- (f) In Q6.8 most candidates could not explain:
 - The purpose of the first stage of the VSD
 - How the three pairs of switches control the positive part of the output voltage and the negative part of the output voltage

- (g) In Q6.8.3 most candidates could not explain how the waveform and the frequency will be affected if the switches remain 'ON' for a longer period.
- (h) Many candidates could not explain how regenerative braking is achieved in Q6.10.2.
- (i) In Q6.11.2 most candidates could not describe the start-up and run profile of the induction motor.

Suggestions for Improvement

- (a) Learners must:
- Differentiate between *general safety* and *specific safety* with regard to PLCs
 - Convert hard-wired diagrams into ladder logic diagrams and simulate them practically
- (b) Learners must be able to interpret the operation of the ladder diagram in relation to the input and output pulses.
- (c) All ladder diagrams must be drawn correctly with all labels. Learners should know IEC as well as American symbols for logic gates.
- (d) The operation of the VSD must be explained in terms of their stages.
- (e) Learners should know:
- About regenerative braking
 - The conversion from one form of energy to another during the braking process
 - The purpose of the braking resistor as used in the motor control circuit
 - Examples of regenerative braking
 - The diagram showing how regenerative braking is applied to a motor control circuit
- (f) Regarding start-up and run profiles with applications, the following should be emphasised:
- Characteristics of the curve of speed vs. torque
 - Understanding of the relationship between speed and torque
 - Knowledge and understanding of the torque range
 - Characteristics of the curve of current vs. torque
 - Understanding of the relationship between current and torque

Chapter 6

MECHANICAL TECHNOLOGY

6.1 AUTOMOTIVE

The following report should be read in conjunction with the Automotive question paper of the November 2019 examinations.

6.1.1 PERFORMANCE TRENDS (2018–2019)

In 2019, 2 784 candidates sat for the Automotive examination. This was the second examination in which the specialisation subjects were examined. The candidates performed well, with 95,4% of the cohort passing at the 30% level and above.

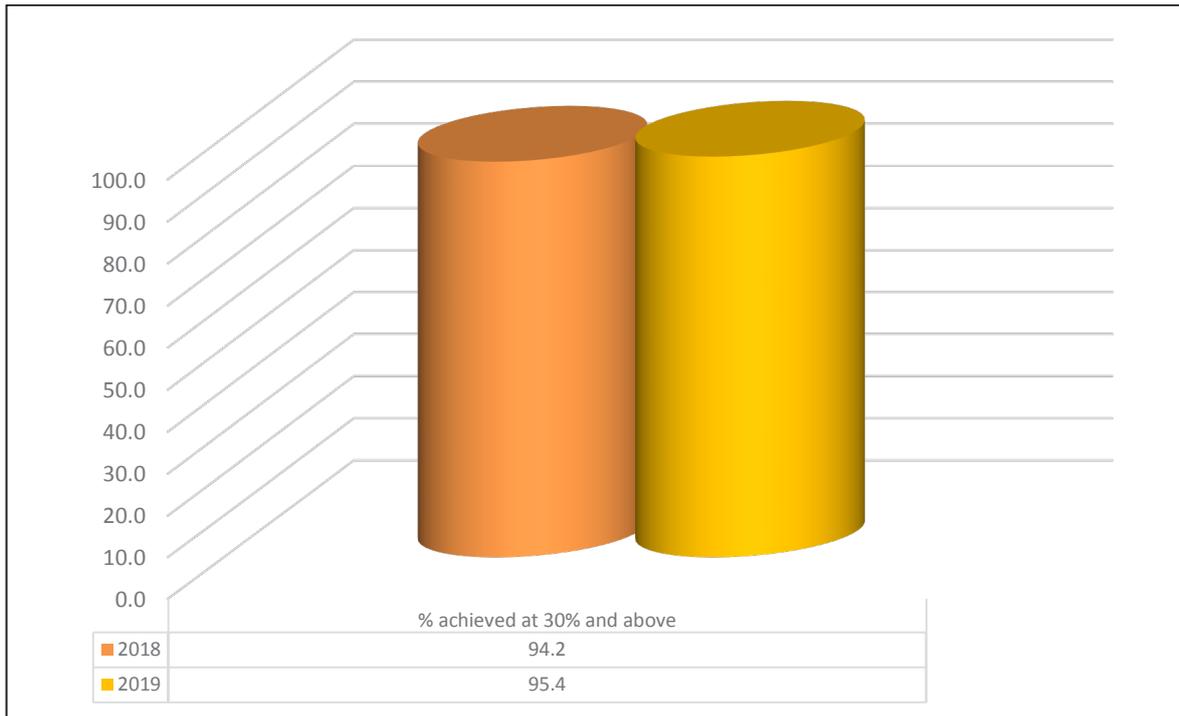
The results may improve in future, with stability in the curriculum and with teachers and learners becoming familiar with the assessment style of the subject.

Table 6.1.1 (a) Overall Achievement Rates in Automotive

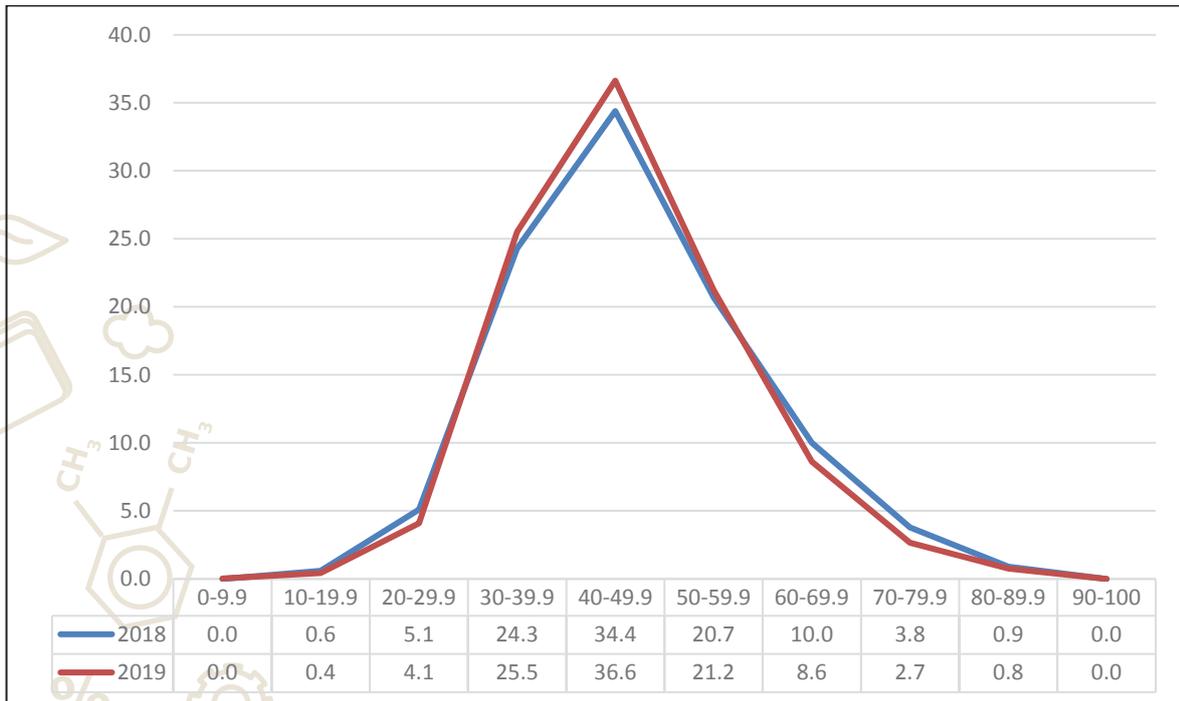
Year	No. Wrote	No. achieved at 30% and above	% achieved at 30% and above
2018	2 986	2 814	94,2
2019	2 784	2 657	95,4

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 6.1.1(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 PAPER

General Comments

- (a) Questions pertaining to pure recall of content were very poorly answered. Teachers are advised to use short informal assessment tasks to reinforce basic concepts and principles. This can be used to good effect for content relating to definitions, functions, labelling and operations listed in the *CAPS* and the *Examination Guidelines*.
- (b) Some candidates did not apply formulae correctly. Teachers should emphasise the 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 a challenge for many candidates. Learners should be given a variety of problem-solving activities that involve mathematical knowledge pertaining to the manipulation of formulae and the application of trigonometry in 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.
- (e) Learners need to be taught language skills in order to distinguish among terms such as 'before', 'during', 'while' and 'after'.
- (f) Candidates do not appear to read questions carefully and consequently do not answer certain subquestions appropriately.
- (g) Candidates revealed a lack of knowledge of or exposure to the use of various tools and equipment.
- (h) Teachers should use previous 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) Theory and practical tasks should 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. Questions should assess factual content, calculations and drawings.
- (m) Moderation by SMTs and/or PEDs will serve to ensure that the curriculum is covered in time.
- (n) Teacher training needs to focus on the setting of 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 to all schools offering practical assessment tasks by the PED, strictly meant for the purchasing 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.

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 candidates could not identify the correct properties of materials.
- (b) Q1.5 candidates did not know the definition of the *hardness of steel*. They stated the purpose of the different heat treatments instead of the processes.

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) Teachers should ensure in-depth revision and remedial measures on the topics of safety and materials. The use of past question papers is encouraged in order to prepare learners to respond with reasons to multiple-choice questions. 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) Q2.1 specifically asked for safety precautions that must be observed before operating a machine but candidates provided general safety precautions which included precautions that must be observed during and after the operation of a machine.

- (b) In Q2.3 candidates could not differentiate between safety on the drill press and the hydraulic press.
- (c) In Q2.4 candidates did not know that by using surgical gloves, a person can prevent infection and protect the wound against contamination.
- (d) In Q2.6 and Q2.7 some candidates were not able to differentiate between the responsibilities of the employer and the responsibilities of the employee with regard to safety in the workshop.

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.
- (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 the candidates' responses indicated a lack of theoretical knowledge as well as practical application.
- (b) In Q3.4 candidates gave the purpose of heat-treatment processes instead of describing how heat-treatment processes are carried out on steel.

Suggestions for Improvement

- (a) A 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.
- (b) The correct terminology of materials should be used during teaching.

QUESTION 4: MULTIPLE-CHOICE QUESTIONS

Common Errors and Misconceptions

- (a) Some multiple-choice questions were left unanswered due to a lack of content knowledge by candidates.
- (b) Q4.14 was poorly answered as candidates were unfamiliar with the purpose of the brake band in an automatic gearbox.

Suggestions for Improvement

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 candidates could not label the part marked A on a cylinder leakage tester.
- (b) In Q5.1.3 candidates could not write the correct sequence required to set up a cylinder leakage tester.
- (c) In Q5.4 candidates could not state the purpose of a turn-table.
- (d) Q5.5 asked candidates to list the three outcomes of dynamic wheel balancing but they wrote on factors of dynamic wheel balancing instead.

Suggestions for Improvement

- (a) Learners should be exposed to all tools as prescribed in the *CAPS* for Automotive, they should know the purpose of the tools and be able to use them correctly. 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.

QUESTION 6: ENGINES

Common Errors and Misconceptions

- (a) In Q6.3 candidates could not identify the factors that would determine the firing order of an engine.
- (b) In Q6.7.3 candidates could not identify the supercharger and could not describe its operation.

Suggestions for Improvement

- (a) Teachers must emphasise that there is a distinct difference between the firing order of a *V-type engine* and the firing order of an *in-line engine*. In addition, video clips from YouTube and charts should be used to integrate theory with practical tasks in the workshop.
- (b) Use videos and models to demonstrate the operation of both the supercharger and the turbocharger. Teachers should teach the theory and apply it practically for the candidates to conceptualise the content.

QUESTION 7: FORCES

Common Errors and Misconceptions

- (a) In Q7.3.2 most of the candidates used the correct formula but could not manipulate the formula correctly when calculating the original clearance volume.
- (b) In Q7.3.3 candidates could not manipulate the formula to calculate the new bore diameter using the original clearance volume in Q7.3.2.
- (c) In Q7.4 candidates could not convert standard units to the required units. Many candidates were challenged by the mathematical concepts which are essential for such calculations.
- (d) In Q7.5 candidates could not define mechanical efficiency and brake power, as applied to internal combustion engines.

Suggestions for Improvement

- (a) The manipulation of formulae forms the basis of calculation 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. Do each subcalculation separately indicating the conversion of the unit and then apply the main formulae. Use a line sketch to define *swept* and *clearance volume*.

- (c) 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 candidates did not differentiate between a *radiator cap* and a *radiator testing procedure*.
- (b) Many candidates were challenged by Q8.4. They were asked to state four safety measures when conducting a compression test but instead they explained how a compression test should be conducted.

Suggestions for Improvement

- (a) Learners should be able to interpret a manufacturers' specification manual and how to apply the specifications correctly when conducting the pressure test of the cooling system and radiator cap. 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 compression test to emphasise the difference between safety measures and the compression-testing procedures.

QUESTION 9: SYSTEMS AND CONTROL (AUTOMATIC GEARBOX)

Common Errors and Misconceptions

In Q9.4 candidates could not identify the components of the torque converter, its advantages and torque multiplication.

Suggestions for Improvement

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.

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

Common Errors and Misconceptions

- (a) In Q10.2 candidates were unable to state the requirements of a well-designed steering mechanism.
- (b) In Q10.4 candidates were unable to draw and label the sketch of the Ackermann angle layout.

- (c) In Q10.7 candidates could not state the purpose of the catalytic converter.
- (d) In Q10.9 functions of the slip-ring and brush of an alternator were poorly stated.
- (e) In Q10.11 candidates were unable to state the advantages of an electrical fuel pump on fuel systems.

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 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, 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.
- (e) Draw up a worksheet for learners to complete regarding the difference between an *electrical* and a *mechanical fuel pump* and the advantages and disadvantages of each. Alternatively, they can use video clips to demonstrate how electrical and mechanical fuel pumps operate.

6.2 FITTING AND MACHINING

The following report should be read in conjunction with the Fitting and Machining question paper of the November 2019 examinations.

6.2.1 PERFORMANCE TRENDS (2018-2019)

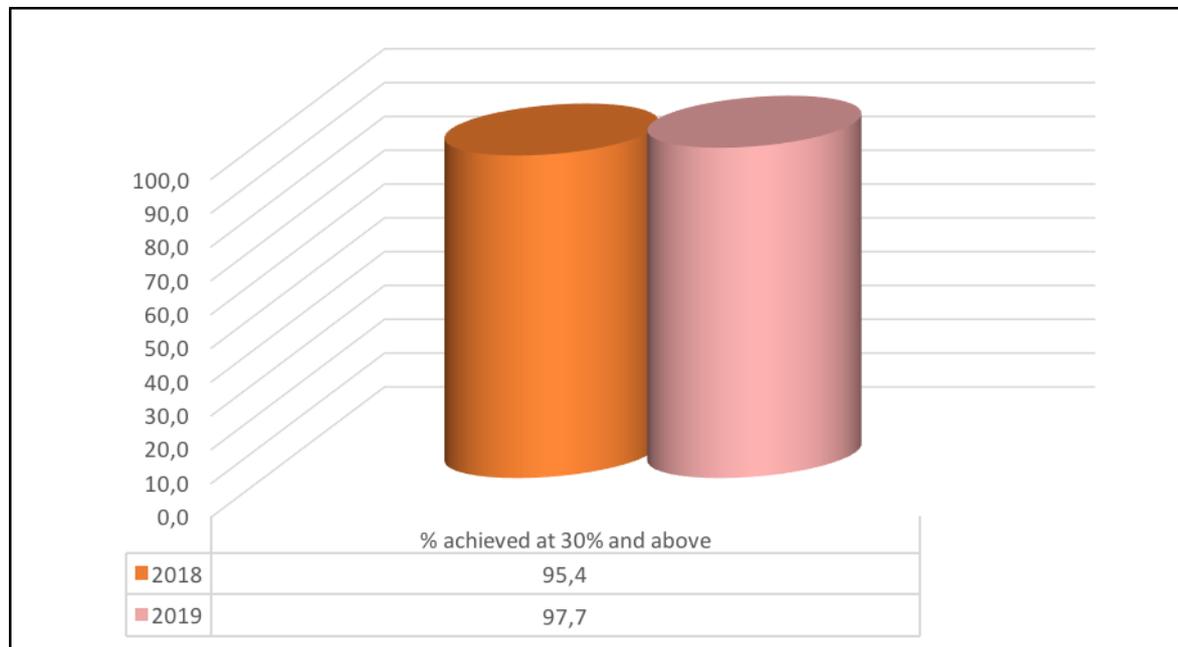
In 2019, 2 012 candidates sat for the Fitting and Machining examination. This was the second examination of the specialisation subjects. The performance of the candidates in 2019 reflects a good achievement, with 97,7% of the cohort passing at the 30% level and above.

Table 6.2.1(a) Overall Achievement Rates in Fitting and Machining

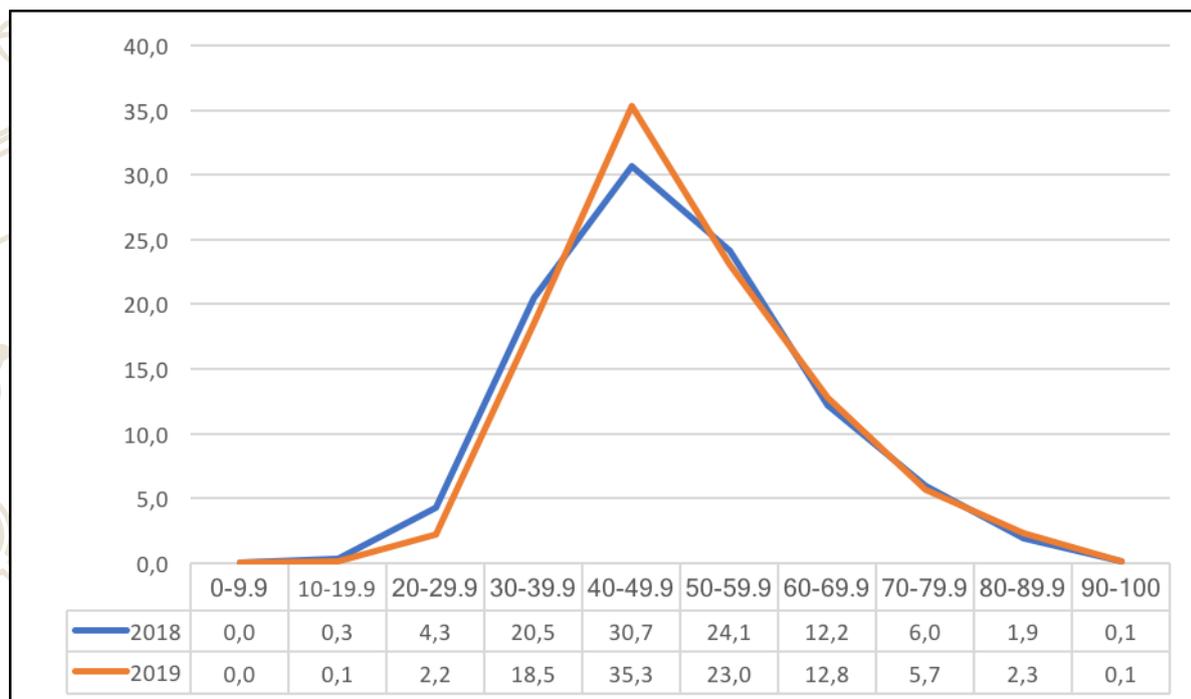
Year	No. Wrote	No. achieved at 30% and above	% achieved at 30% and above
2018	2 088	1 992	95,4
2019	2 012	1 966	97,7

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 FITTING AND MACHINING

General Comments

- (a) Questions pertaining to pure recall of content were very poorly answered. Teachers are advised to use short informal assessment tasks to reinforce basic concepts and principles. This can be used to good effect in content relating to definitions, functions, labelling and operations listed in the *CAPS* and the *Examination Guidelines*.
- (b) Some candidates cannot apply formulae correctly. Teachers should emphasise the use of the relevant formulae provided on the formula sheet, correct substitution 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 a challenge for many candidates. Learners should be given a variety of problem-solving activities that involves mathematical knowledge pertaining to the manipulation of formulae and the application of trigonometry in 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.
- (e) Learners need to be taught language skills to distinguish between terms such as 'before', 'during', 'while' and 'after'.
- (f) Candidates do not appear to read questions carefully and consequently do not answer certain subquestions.
- (g) Candidates revealed a lack of knowledge of or exposure to the use of various tools and equipment.
- (h) Teachers should use previous papers as support material and as exercises in the classroom, especially when training learners to answer multiple-choice questions.
- (i) Worksheets and regular informal assessment will benefit learners.
- (j) 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.
- (k) The 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. Questions should assess factual content, calculations and drawings.
- (m) Moderation by SMTs and/or PEDs will serve to ensure that the curriculum is covered in time.
- (n) Teacher training needs to focus on the setting of papers according to cognitive levels (tests and examination). Sufficient resources are available for this purpose.

- (o) Schools need to adhere to the notional time when setting timetables. Double periods should be allocated for practical tasks.
- (p) Schools and the PED need to support teachers with resources. It became clear in the responses from the learners that they have no idea what some of the tools and equipment look like because they are not available in the workshops at school.
- (q) Worksheets and regular informal assessments will benefit learners; and theory and practice should be integrated in teaching and learning
- (r) Recommend that General comments from Automotive be copied as is to Fitting and Machining.

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 candidates could not identify the correct properties of materials.
- (b) In Q1.5 Candidates did not know the definition of the *hardness of steel*. They stated the purpose of the different heat treatments instead of the processes.

Suggestions for Improvement

- (a) Teachers must provide worksheets to identify the different properties of materials and then practically demonstrate these properties in the workshop.
- (b) Teachers should ensure in-depth revision and remedial measures on the topics of safety and materials. The use of past question papers is encouraged in order to prepare learners to respond with reasons to multiple-choice questions. 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) Q2.1 specifically asked for safety precautions that must be observed before operating a machine but candidates provided general safety precautions which included precautions that must be observed during and after the operation of a machine.

- (b) In Q2.3 candidates could not differentiate between safety on the drill press and the hydraulic press.
- (c) In Q2.4 candidates did not know that by using surgical gloves, a person can prevent infection and protect the wound against contamination.
- (d) In Q2.6 and Q2.7 some candidates were not able to differentiate between the responsibilities of the employer and the responsibilities of the employee with regard to safety in the workshop.

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. Learners need to be reminded that no marks are allocated to correct facts that are not related to the question at hand.
- (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 in answering these types of questions on 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 the candidates' responses indicated a lack of theoretical knowledge as well as practical application.
- (b) In Q3.4 candidates gave the purpose of heat-treatment processes instead of describing how heat-treatment processes are carried out on steel.

Suggestions for Improvement

- (a) 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.
- (b) The correct terminology of materials should be used during teaching.

QUESTION 4: MULTIPLE-CHOICE QUESTIONS

Common Errors and Misconceptions

- (a) Candidates did not read the questions carefully and hence provided poor quality answers.
- (b) Candidates did not understand the term *incremental programming* on three-axis digital read-out system. This hampered their answering of Q4.4.

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 term *incremental programming* on a three-axis digital read-out system. A practical demonstration will enhance learners' understanding of this term.

QUESTION 5: TERMINOLOGY – LATHE AND MILLING MACHINE

Common Errors and Misconceptions

- (a) Q5.1.1 required candidates to calculate the small diameter of the taper. This formula was not provided in the formula sheet. The correct formula is $\frac{\theta}{2} = \frac{D-d}{2 \times L}$ while the response from the candidates was $\tan \theta = \frac{D-d}{2 \times L}$
- (b) Answers to Q5.1 showed that candidates lacked the mathematical skills required of them.
- (c) This question was based on the theory of the practical application of skills regarding the milling processes. The candidates who did not perform well could not relate to the content in practice.
- (d) Drawing of a straddle milling was not clear and many drawings were not labelled.
- (e) There was a lack of knowledge regarding the milling processes.
- (f) Candidates did not work systematically through calculations.

Suggestions for Improvement

- (a) The subject needs to be integrated 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) The performance of practical tasks can assist learners to understand the concepts and processes. This should translate into learners answering the questions better.
- (d) Teach the drawing of all milling processes according to a standard. Learners must use drawing instruments and label the drawing.
- (e) Mathematical skills can only improve with practice. Use the following calculation procedure:
 - Formula
 - Formula manipulation (if necessary)
 - Substitution (correct values or units)
 - Answer with unit of measure indicated

QUESTION 6: TERMINOLOGY – INDEXING AND DOVETAILS

Common Errors and Misconceptions

- (a) Q6.1.2 was a challenge because the formula was not given. Very poor performance was recorded for Q6.2 based on angular indexing and for Q6.3 which was based on change gears.
- (b) Candidates did not give the final answers for indexing. (3 full turns and 42 holes on the 54-hole circle).
- (c) There were poor responses to the dovetail calculation in Q6.4.

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.

QUESTION 7: TOOLS AND EQUIPMENT

Common Errors and Misconceptions

- (a) The drawing of hardness tests in Q7.1 was not clear and many diagrams were not labelled.
- (b) This question was based on the theory of practical application of skills regarding the testing of material and measuring. The candidates who did not perform well could not relate to the content in practice.
- (c) The calculation of the depth micrometer reading in Q7.3 and identifying the screw thread micrometer in Q7.4 were problematic.

Suggestions for Improvement

- 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.
- Teachers should make use of electronic media and practical exercises to cover the content on testers used to determine specific properties of materials and on the reading of micrometers.
- Learners must know the names and uses of the tools that they are using. Create practical tasks to improve measuring skills using Vernier callipers and micrometers.

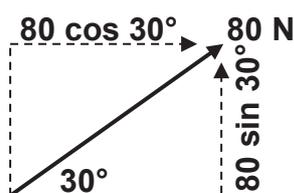
QUESTION 8: FORCES

Common Errors and Misconceptions

- Candidates did not read Q8.1 properly. In this question they were required to calculate the equilibrant, but many candidates calculated the resultant. Further, they ignored the hint provided.
- UDL was a problem for a number of candidates. Candidates did not work systematically through their calculations.
- Calculations with exponents, in Q8.3, was a great challenge for the candidates. They were unable to state the required units of measure. Further, candidates were not able to work with formulae on stress calculations.

Suggestions for Improvement

- Learners must focus on the keywords in the question, e.g. equilibrant or resultant. Drawing a sketch will assist learners in determining the formulae as shown below.



- Learners should be encouraged to perform the calculation systematically according to the following steps:
 - Formula
 - Formula manipulation (if necessary)
 - Substitution (correct values or units)
 - Answer with unit of measure
- Mathematical skills can only improve with practice. Learners should use exponents and the correct unit in the answer.
- 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.

QUESTION 9: MAINTENANCE

Common Errors and Misconceptions

- (a) There was very poor performance in Q9 indicating very little or no knowledge of the required content.
- (b) Candidates' answers indicate a lack of practical experience in respect of maintenance.
- (c) Candidates had difficulty giving a reason or providing an explanation or stating a procedure.

Suggestions for Improvement

- (a) Teachers should receive more training to understand the content of this section. Resources on this content are available through videos and on the internet.
- (b) Maintenance procedures cannot be learnt from a book. It has to be observed or performed in practice. Design practical tasks that involve maintenance procedures. Record the procedures in point form.
- (c) Teach the correct terminology as it relates to maintenance.

QUESTION 10: JOINING METHODS

Common Errors and Misconceptions

- (a) Candidates lacked knowledge of the screw thread, including drawings and the definitions of screw-thread terms.
- (b) Many candidates did not convert to the correct units before performing the calculation, e.g. converting millimetres to metres.
- (c) Candidates were unable to define the given terms.

Suggestions for Improvement

- (a) Teachers need to create a standard for drawing diagrams of screw threads. Teach all screw-thread terminology according to this standard. The use of drawing instruments and labelling of the diagram are important.
- (b) Learners should work systematically through calculations according to the following steps:
 - Formula
 - Formula manipulation (if necessary)
 - Substitution (correct values or units)
 - Answer with unit of measure

QUESTION 11: SYTEMS AND CONTROL

Common Errors and Misconceptions

- (a) Q11.2, Q11.4.2 and Q11.4.3 were answered very poorly due to a lack of mathematical skills. Candidates lost marks because when the first calculation was incorrect, the next calculation would also be incorrect, e.g. Q11.2.1 – Q11.2.2 and Q11.4.2 – Q11.4.3.
- (b) Candidates were able apply the formulae correctly but gave the answer in the incorrect unit of measure.

Suggestions for Improvement

- (a) Mathematical skill can only improve with practice.
- (b) Learners must work systematically through calculations according to the following steps:
- Formula
 - Formula manipulation (if necessary)
 - Substitution (correct values or units)
 - Answer with unit
- (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 2019 examinations.

6.3.1 PERFORMANCE TRENDS (2018-2019)

In 2019, 1 682 candidates sat for the Welding and Metalwork examination. This was the second examination of the specialisation subjects. The performance of the candidates in 2019 reflects a slight decrease from 2018, with 92,3% of the cohort passing at the 30% level and above.

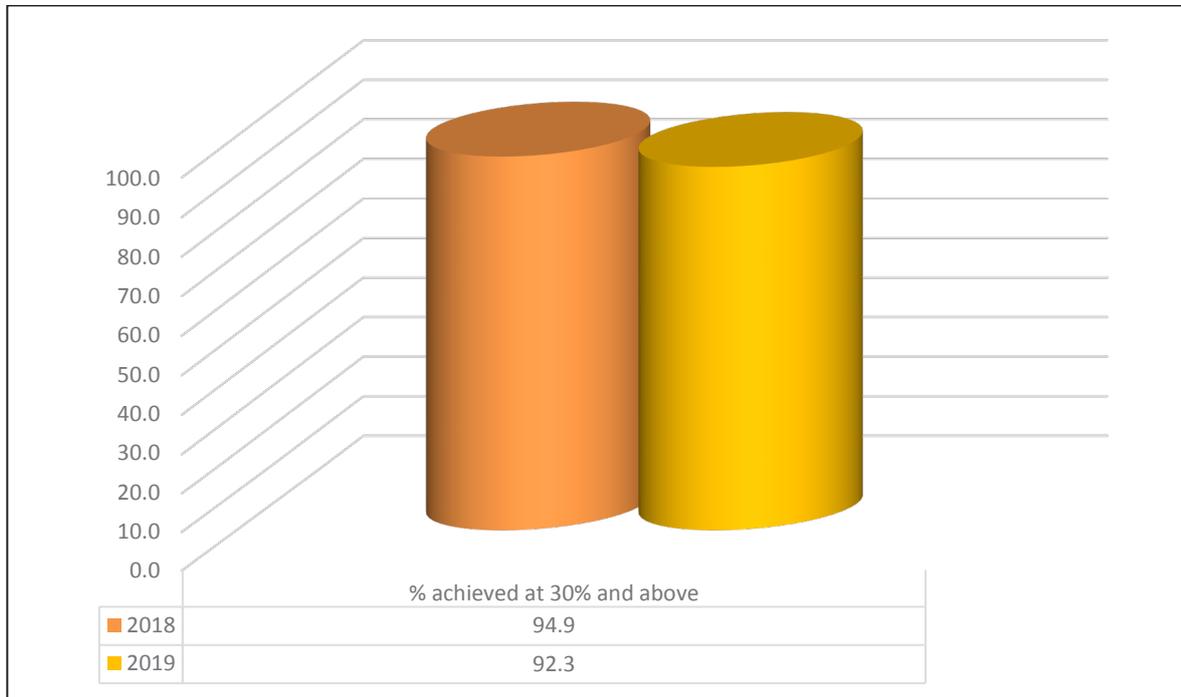
The results may improve in future, with stability in the curriculum and with teachers and learners becoming familiar with the assessment style of the subject.

Table 6.3.1(a) Overall Achievement Rates in Welding and Metalwork

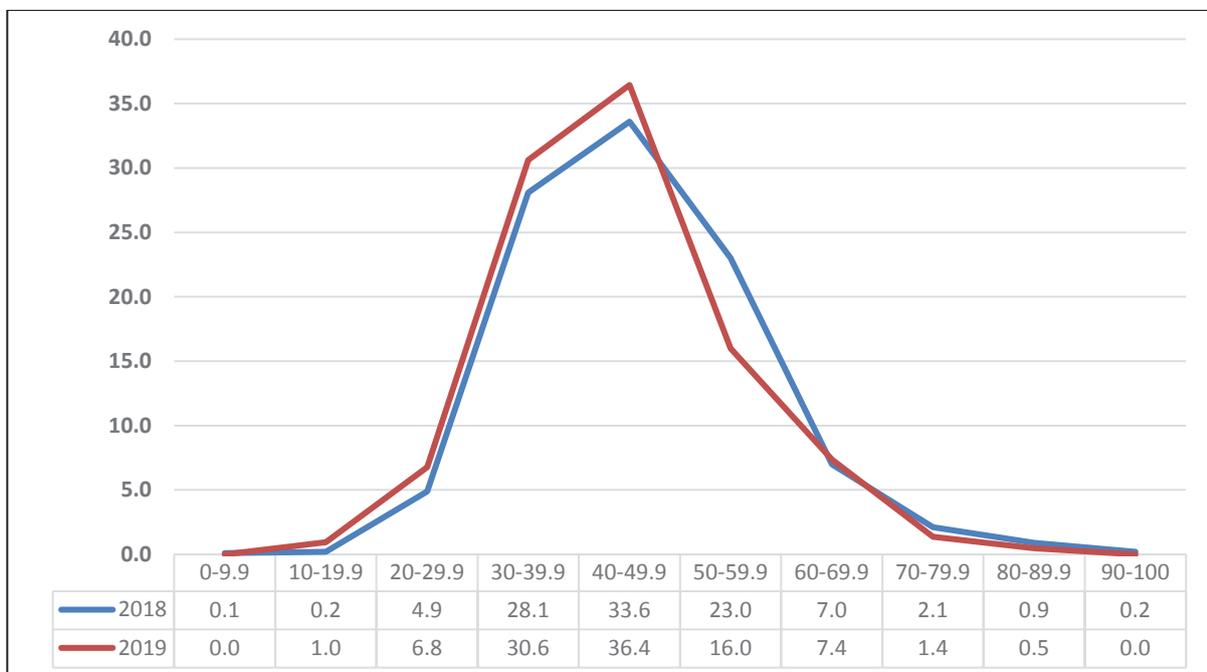
Year	No. Wrote	No. achieved at 30% and above	% achieved at 30% and above
2018	1 934	1 835	94,9
2019	1 682	1 552	92,3

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 PAPER

General Comments

- (a) Questions pertaining to pure recall of content were very poorly answered. Teachers are advised to use short informal assessment tasks to reinforce basic concepts and principles. This can be used to good effect in content relating to definitions, functions, labelling and operations listed in the *CAPS* and the *Examination Guidelines*.
- (b) Some candidates could not apply formulae correctly. Teachers should emphasise the use of the relevant formulae provided on the formula sheet, correct substitution 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 a challenge for many candidates. Learners should be given a variety of problem-solving activities that involve mathematical knowledge pertaining to the manipulation of formulae and the application of trigonometry in 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 presented neatly.
- (e) Learners need to be taught language skills in order to distinguish between terms such as 'before', 'during', 'while' and 'after'.
- (f) Candidates do not appear to read questions carefully and consequently do not answer certain subquestions.
- (g) Candidates revealed a lack of knowledge of or exposure to the use of various tools and equipment.
- (h) Teachers should use previous papers as support material and as exercises in the classroom especially when training learners to answer multiple-choice questions.
- (i) Worksheets and regular informal assessments will benefit learners; and theory and practice should be integrated in teaching and learning.
- (j) 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.
- (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. Questions should assess factual content, calculations and drawings.
- (m) Moderation by SMTs and/or PEDs will serve to ensure that the curriculum is covered in time.
- (n) Teacher training needs to focus on the setting of papers according to cognitive levels (tests and examination). Sufficient resources are available for this purpose.

- (o) Funding should be made available to all schools offering practical assessment tasks by PEDs, strictly meant for purchasing of consumable materials.
- (p) Schools need to adhere to the notional time when setting timetables. Double periods should be allocated for practical tasks.
- (q) 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
- (r) Recommend that General comments from Automotive be copied as is to Welding and Metalwork.

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 candidates could not identify the correct properties of materials.
- (b) Q1.5 Candidates did not know the definition of *hardness of steel*. They stated the purpose of the different heat treatments instead of the processes.

Suggestions for Improvement

- (a) Teachers must provide worksheets to identify the different properties of materials and then practically demonstrate these properties in the workshop.
- (b) Teachers should ensure in-depth revision and remedial measures on the topics of safety and materials. The use of past question papers is encouraged in order to prepare learners to respond with reasons to multiple-choice questions. 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) Q2.1 specifically asked for safety precautions that must be observed before operating a machine but candidates provided general safety precautions which included precautions that must be observed during and after the operation of a machine.

- (b) In Q2.3 candidates could not differentiate between safety on the drill press and the hydraulic press.
- (c) In Q2.4 candidates did not know that by using surgical gloves, a person can prevent infection and protect the wound against contamination.
- (d) In Q2.6 and Q2.7 some candidates were not able to differentiate between the responsibilities of the employer and the responsibilities of an employee with regard to safety in the workshop.

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 safety of tools, equipment 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 in answering these types of questions on 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 the candidates' responses indicated a lack of theoretical knowledge as well as practical application.
- (b) In Q3.4 candidates gave the purpose of heat-treatment processes instead of describing how heat-treatment processes are carried out on steel.

Suggestions for Improvement

- (a) 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

Most learners performed well in this question which covered multiple-choice items on specific content.

Suggestions for Improvement

Continue to give sufficient informal tasks containing multiple choice in different topics.

QUESTION 5: TERMINOLOGY

Common Errors and Misconceptions

- (a) Q5.2 required the definition of a *plate girder*. Most candidates provided a description of a plate girder instead of defining it.
- (b) In Q5.3 most candidates were unfamiliar with examples of fusion welds.

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) Learners should practise with previous exemplar papers.
- (c) Practical work is a necessity.
- (d) Correct technical terminology should be used. Posters to illustrate concepts and terminology should be put up in class.

QUESTION 6: TOOLS AND EQUIPMENT

Common Errors and Misconceptions

In Q6.1.2 candidates did not know how to describe the working principles of a machine as opposed to what the machine is used for.

Suggestions for Improvement

- (a) Learners should practise with previous exemplar papers.
- (b) Teachers should emphasise the difference between *working principles* and the *purpose* of machines.
- (c) Learners will benefit from practical exposure to the equipment.

QUESTION 7: FORCES

Common Errors and Misconceptions

- (a) In Q7.1 candidates lacked mathematical and drawing skills. They did not use correct units in their answers.
- (b) Answers to Q7.2.1 revealed that candidates switched the reactions to the left of the beam with those to the right of the beam.
- (c) Candidates were unfamiliar with calculations related to shear force and bending moment that were required in Q7.2.2.
- (d) In Q7.2.3 candidates struggled to draw bending moment and shear force diagrams according to a prescribed scale.

Suggestions for Improvement

- (a) Learners should practise with previous exemplar papers.
- (b) Learners should be exposed to more exercises related to the reaction of beams.
- (c) Learners should practise their mathematical skills. Supporting subjects like Mathematics, Technical Mathematics and Technical Sciences should emphasise relevant sections related to forces.
- (d) There should be more exposure to exercises that enhance competency in drawing skills.

QUESTION 8: JOINING METHODS – WELD INSPECTION

Common Errors and Misconceptions

- (a) In Q8.4 candidates had to state arc welding defects. Instead they stated the causes of the defects. They did not have practical knowledge of the inspection of welds.
- (b) Candidates were unfamiliar with the procedure to conduct an X-ray test.

Suggestions for Improvement

- (a) Learners should be taught to read questions carefully with understanding.
- (b) Learners should be exposed to previous examination papers.

QUESTION 9: JOINING METHODS – STRESSES AND DISTORTION

Common Errors and Misconceptions

In Q9.2 candidates did not understand the effect of cooling on a weld.

Suggestions for Improvement

Learners should be exposed to videos during lessons as well as simulations on the effect of cooling on a weld.

QUESTION 10: MAINTENANCE

Common Errors and Misconceptions

In Q10.2 candidates could not answer on the procedures in industry because they probably had not have encountered these procedures at school. They lacked experience on maintenance procedures.

Suggestions for Improvement

Learners should be given more informal assessment tasks and they should be exposed to industrial site visits.

QUESTION 11: DEVELOPMENT BY CALCULATIONS

Common Errors and Misconceptions

In Q11.1.1–Q11.1.5 candidates did not know how to calculate horizontally and vertically. They calculated the base horizontally, but they left out the vertical calculation.

Suggestions for Improvement

Learners must practise calculations extensively in order to develop more confidence to work with them. Different methods to derive an answer should be explored as learners may not understand one method but could understand an alternative method.

