

CHAPTER 6

MECHANICAL TECHNOLOGY

6.1 AUTOMOTIVE

The following report should be read in conjunction with the Automotive question paper of the December 2021 examinations.

6.1.1 PERFORMANCE TRENDS (2018–2021)

This was the fourth examination in which the specialisation subjects were examined. In 2021, 3 330 candidates sat for the Automotive examination, which was an increase of 491 candidates in comparison to the previous year.

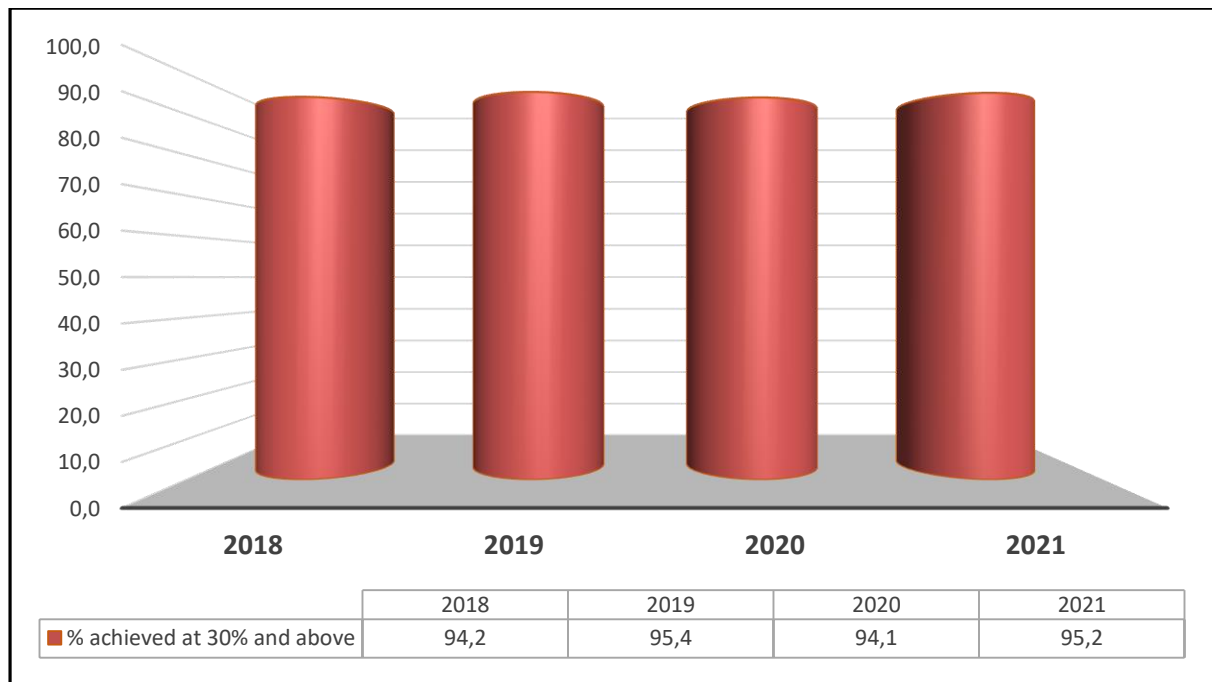
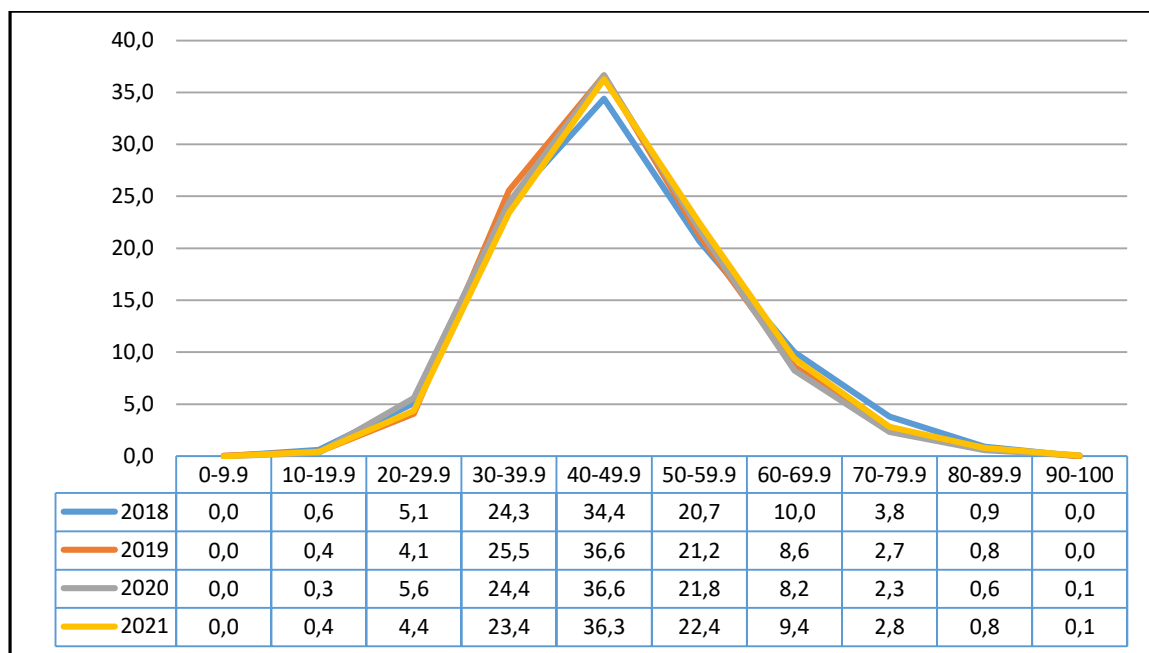
The candidates performed well, with 95,2% of the cohort passing at 30% (Level 2). This reflects an improvement on the 2020 pass rate of 94,1%.

The percentage of distinctions (80%; Level 7) increased marginally to 0,9% in 2021. This converts to an increase in the number of distinctions from 21 to 30. Candidates who achieved over 50% comprised 35,5% of the cohort which was in line with that of previous years.

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. Candidates' performance in the 2021 examination was marginally better when compared to 2020. Their problem-solving skills, mathematical skills and conceptual understanding still remain a challenge. In this regard, integrated problem-solving must become an integral part of teaching and learning.

Table 6.1.1 Overall achievement rates in Automotive

Year	No. wrote	No. achieved at 30% and above	% achieved at 30% and above
2018	2 986	2 814	94,2
2019	2 784	2 657	95,4
2020	2 839	2 671	94,1
2021	3 330	3 171	95,2

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 CANDIDATES' PERFORMANCE IN THE AUTOMOTIVE PAPER

General comments

- (a) The majority of the questions pertaining to pure recall of content were very poorly answered. Short informal assessment tasks should be used to reinforce basic concepts and principles. This can be used effectively for content relating to definitions, functions, labelling and operations as listed in the CAPS and the *Examination Guidelines*.
- (b) Candidates did not manipulate formulae correctly. Teachers must emphasise the following: use of the relevant formulae provided on the formula sheet, correct substitution thereof and providing the answer with the correct unit and direction in terms of what is required by the question.
- (c) The application of mathematical principles is still a challenge for candidates
- (d) Candidates' handwriting should not be too small and calculations should not be cramped onto one section of the page. Candidates should ensure that their work is legible and neatly presented and they should also be able to follow the instructions on the cover.
- (e) It appears that candidates do not read questions carefully and consequently do not answer certain subquestions appropriately.
- (f) Candidates lacked knowledge of, or exposure to, the use of various tools and equipment.
- (g) Many candidates and teachers were frequently absent from school due to quarantines or isolation in respect of Covid-19. Non-attendance of school means both candidates and teachers had missed important contact time. Candidates were further impacted by the lack of contact time in Grade 11 due to shortened school weeks the previous year. The knowledge and understanding gained in Grade 11 were fundamental to their proper preparation. Contact time was also negatively impacted due to time-tabling models and limited class sizes.

6.1.3 ANALYSIS OF CANDIDATES' PERFORMANCE IN EACH QUESTION IN AUTOMOTIVE

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Common errors and misconceptions

- (a) The majority of candidates did not know the purpose of the *hardening of steel* in Q1.5.
- (b) In Q1.6, most of the candidates could not identify the correct process that follows hardening.

Suggestions for improvement

- (a) Teachers should provide worksheets to identify the different properties of materials and then practically demonstrate these properties and processes in the workshop.

- (b) Teachers should make use of practical demonstrations to explain the definitions of the properties of steel.
- (c) Ensure in-depth revision and remediation measures are in place on the topics of safety and materials. In order to prepare learners to respond with reasons to multiple-choice questions, the use of past question papers is encouraged. They must 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.

QUESTION 2: SAFETY

Common errors and misconceptions

- (a) In Q2.1 some candidates were unable to provide the specific measures to be taken when treating an open wound. They stated prevention and contamination of the open wound.
- (b) Q2.2 specifically asked for safety precautions that must be observed *after* the surface grinder has been switched on, instead candidates provided general safety precautions that included precautions that must be observed before and during the operation of a machine.
- (c) In Q2.6 majority of the candidates could not identify the type of workshop showed in the figure.

Suggestions for improvement

- (a) When using tools and equipment, demonstrate the importance of using surgical gloves when someone cuts himself or herself. Video presentations and demonstrations would give learners an advantage when answering these types of questions on first aid. Also state who is responsible for the administering of first aid.
- (b) 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.
- (c) Learners should be exposed to workshop practice relating to the safety of tools, the equipment in the workshop and the workshop environment.
- (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 Q3.2 the candidates' responses indicated a lack of theoretical knowledge, as well as practical application when labelling the drawing about the annealing process.
- (b) In Q3.5 the majority of the candidates did not know which quenching media had to be used to harden steel.

Suggestions for improvement

- (a) Learners should be exposed to the different processes to enhance the properties of metal.
- (b) The revision programme must include exercises requiring explanation, definition and application of heat-treatment processes. Schools need to organise educational excursions to foundries or other places where materials are processed in order to acquaint learners with metallurgy and to further improve their understanding of the processes involved.

QUESTION 4: MULTIPLE-CHOICE QUESTIONS

Common errors and misconceptions

- (a) Most of the multiple-choice questions were incorrectly answered due to a lack of content knowledge by candidates.
- (b) Q4.7 was poorly answered, as most candidates were unable to state the use of dynamometer.
- (c) Q4.10 and Q4.11 were incorrectly answered due to a lack of practical knowledge about automatic transmission system.

Suggestions for improvement

- (a) Learners should be able to distinguish between the different components of an automatic transmission and to provide the function of each component. This could be enhanced by providing learners with a diagram of an automatic gearbox.
- (b) 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 to Q5.1.4 the majority of the candidates could not state the correct sequence of events when conducting a compression test.
- (b) In Q5.5 most of the candidates could not identify the missing safety component of the equipment shown in the diagram.

Suggestions for improvement

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

QUESTION 6: ENGINES

Common errors and misconceptions

- (a) In Q6.1 some candidates could not state how the firing order assisted the functioning of the crankshaft.
- (b) In Q6.7.1 to Q 6.7.4 most candidates could not give the degrees of crankshaft rotation for power impulses of the different four stroke engines.

Suggestions for improvement

- (a) Teachers must emphasise how the firing order assists the functioning of the crankshaft.
- (b) Teachers should cover the theory and demonstrate crankshaft rotation practically so that learners will be able to give the degrees of crankshaft rotation for power impulses of the different four stroke engines.

QUESTION 7: FORCES

Common errors and misconceptions

- (a) Most candidates could not state the definition of brake power in Q7.1.1.
- (b) In Q7.3.1 most candidates could not identify what V_1 and V_2 represented in the diagram showing volumes in the cylinder.
- (c) In Q7.3.3 the majority of the candidates could not calculate the total cylinder volume because they did not know that 1 ml is equal to 1 cm³.
- (d) In Q7.3.4 the majority of the candidates could not manipulate the formula to calculate the new bore diameter using the swept volume in Q7.3.
- (e) In Q7.5.1 some candidates could not calculate indicated power using the information given in the instructions. Candidates could not convert standard units to the required units. Many candidates were challenged by the mathematical concepts which are essential for such calculations.

Suggestions for improvement

- (a) 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*.
- (b) Making use of a line sketch to define *swept* and *clearance volume* is useful to enhance understanding of these concepts.
- (c) The manipulation of formulae forms the basis of calculations in the subject. Learners must be assisted to acquire this skill. Teachers should provide more calculation activities using examples from previous question papers and various textbooks.
- (d) Discuss each step in the calculation using the Indicated Power and Cylinder Volume formulae. Teachers should illustrate how to do each subcalculation indicating the conversion of the unit separately and then applying these results in the main formula.

QUESTION 8: MAINTENANCE

Common errors and misconceptions

- (a) In Q.8.1.1 and Q8.1.2 most candidates were not able to state the causes and corresponding corrective measures for low CO₂ exhaust reading.
- (b) Many candidates were challenged by Q8.7. They were asked to explain in point form how to conduct a radiator cap test but instead they explained how to do a radiator test.

Suggestions for improvement

- (a) When conducting an exhaust gas analysing test, the teacher must draw up a worksheet where learners can indicate causes and corrective measures.
- (b) A practical demonstration of how to do a radiator cap test and a radiator test by the teacher is essential to identify the differences in testing.
- (c) Teachers should also use video clips related to safety measures when conducting all types of test.

QUESTION 9: SYSTEMS AND CONTROL (AUTOMATIC GEARBOX)

Common errors and misconceptions

- (a) In Q9.1.2, the majority of the candidates could not explain the functions of a torque convertor.
- (b) Many candidates were unable to explain how overdrive is obtained in the epicyclic gear train in Q9.2.

Suggestions for improvement

- (a) Teachers should use charts to show the labels of the torque converter, its advantages, functions and its operation. If possible, use a sectioned automatic gearbox or an actual vehicle and videos to show learners the differences in the operation of the power transmission between automatic and manual vehicles.
- (b) Teachers are advised to design a worksheet that will assist learners with identifying various parts and understanding their functions, purposes and advantages and disadvantages of the automatic transmission including the epicyclic gear train.

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

Common errors and misconceptions

- (a) In Q10.1 many candidates were unable to state the reasons for wheel alignment.
- (b) The majority of the candidates were unable to identify causes of camber wear in Q10.2.1.
- (c) In Q10.2.3 the majority of the candidates could not state how camber can be adjusted.
- (d) Most candidates did not read Q10.3 carefully. This question required them to draw and fully label the drawing. Many candidates failed to do this.

- (e) In Q10.5 most candidates did not know the different types of injectors.
- (f) In Q10.8.3 the majority of the candidates could not draw the two types of stator windings used in an alternator.
- (g) Some candidates were unable to state the advantages of electrical fuel pump in Q10.9.

Suggestions for improvement

- (a) Teachers must do the practical application of a steering mechanism so that learners can have a better understanding of the topic.
- (b) Teachers should assign more drawing exercises to allow learners to master all wheel alignment angles, definitions and labels. Take learners to a wheel alignment workshop for learners to understand the alignment and setting of wheel alignment angles. Alternatively, videos can be used to achieve this.
- (c) Use an actual alternator to show the components and explain their stator wiring, functions, operations and methods to increase their frequency as well as safety measures.
- (d) Design a worksheet for learners to complete regarding the difference between an *electrical* and a *mechanical* fuel pump as well as the types, advantages and disadvantages of each. Alternatively, they can use video clips to demonstrate how electrical and mechanical fuel pumps operate.
- (e) Teachers must show learners the different types of injectors. Using videos or charts will be of great assistance.
- (f) Teachers should administer frequent weekly short informal assessment tasks to enhance candidates' knowledge and drill revision work.

6.2 FITTING AND MACHINING

The following report should be read in conjunction with the Fitting and Machining question paper of the November 2021 examinations.

6.2.1 PERFORMANCE TRENDS (2018–2021)

In 2021, 1 991 candidates sat for the Fitting and Machining examination. This was the fourth examination of the specialisation subjects. The performance of the candidates in 2021 reflects good achievement, with 97,1% of the cohort passing at 30% (Level 2). This was a marginal increase over the 2020 pass rate of 96,8%.

The percentage of distinctions (80%; Level 7) decreased from 3,8% in 2020 to 3,1% in 2021 a decrease of 0,9% in 2021. This converts to a decrease in the number of distinctions from 73 to 61. Candidates who achieved over 50% comprised 48,5% of the cohort compared to 41,4% in the previous year.

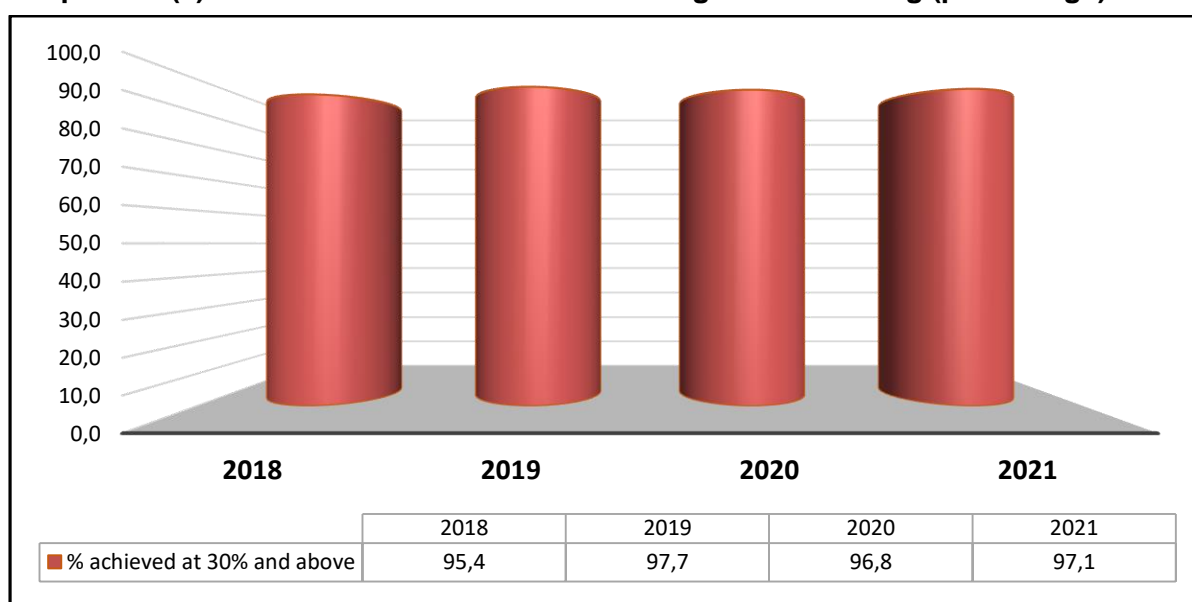
The level of the results may improve in the future with stability in the curriculum as well as with the teachers becoming familiar with the assessment style of the subject. There is still room for improvement in the performance of the learners if the challenges surrounding problem-solving

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.

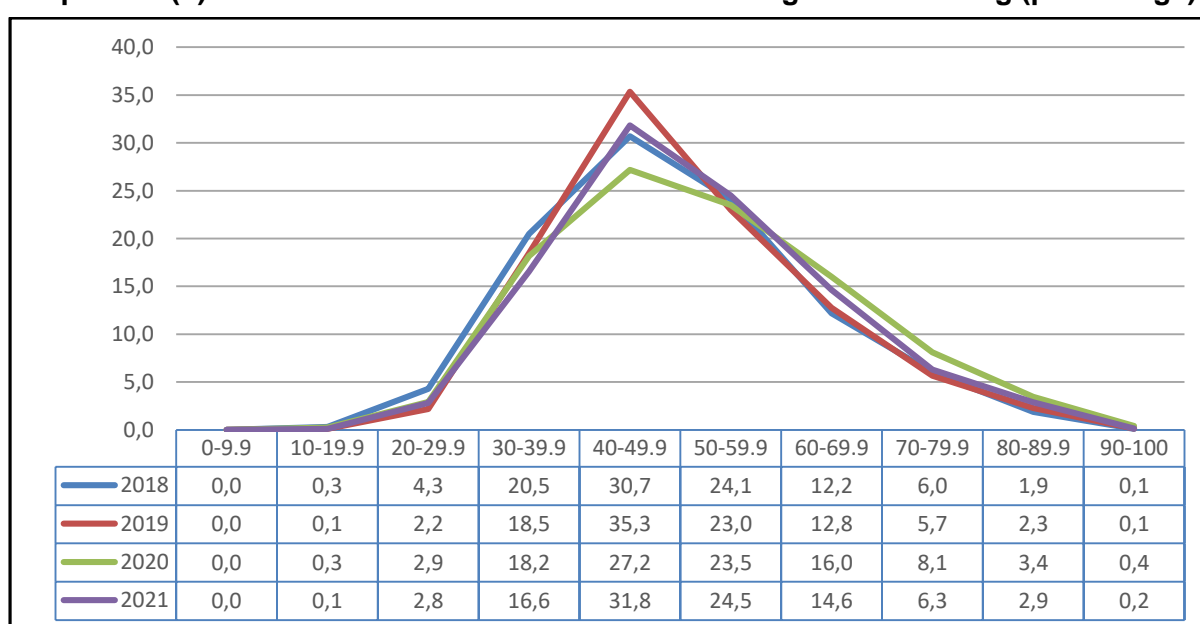
Table 6.2.1 Overall achievement rates in Fitting and Machining

Year	No. wrote	No. achieved at 30% and above	% achieved at 30% and above
2018	2 088	1 992	95,4
2019	2 012	1 966	97,7
2020	1 914	1 853	96,8
2021	1 991	1 933	97,1

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 CANDIDATES' PERFORMANCE IN THE FITTING AND MACHINING PAPER

General comments

- (a) The majority of the questions pertaining to pure recall of content were very poorly answered. Short informal assessment tasks should be used to reinforce basic concepts and principles. This can be used effectively for content relating to definitions, functions, labelling and operations as listed in the *CAPS* and the *Examination Guidelines*.
- (b) Candidates did not manipulate formulae correctly. Teachers must emphasise the following: use of the relevant formulae provided on the formula sheet, correct substitution thereof and providing the answer with the correct unit and direction in terms of what is required by the question.
- (c) The application of mathematical principles is still a challenge for candidates.
- (d) Candidates' handwriting should not be too small and calculations should not be cramped onto one section of the page. Candidates should ensure that their work is legible and neatly presented and they should also be able to follow the instructions on the cover.
- (e) It appears that candidates do not read questions carefully and consequently do not answer certain sub questions appropriately.
- (f) A lack of knowledge of, or exposure to the use of various tools and equipment, was revealed by candidates.
- (g) Many candidates and teachers were frequently absent from school due to quarantines or isolation with regard to Covid-19. Non-attendance of school means both candidates and teachers had missed important contact time. Candidates were further impacted by a lack of contact time in Grade 11 due to shortened school weeks the previous year. The knowledge and understanding gained in Grade 11 were fundamental to their proper preparation. Contact time was also negatively impacted due to time-tabling models and limited class sizes.

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

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Common errors and misconceptions

- (a) The majority of candidates did not know the purpose of the *hardening of steel* in Q1.5.
- (b) In Q1.6 most of the candidates could not identify the correct process that follows hardening.

Suggestions for improvement

- (a) Teachers should provide worksheets to identify the different properties of materials and then practically demonstrate these properties and processes in the workshop.
- (b) Teachers must use practical demonstrations to explain the definitions for the properties of steel.
- (c) Ensure in-depth revision and remediation measures are in place on the topics of safety and materials. In order to prepare learners to respond with reasons to multiple-choice questions, the use of past question papers is encouraged. They must apply their practical knowledge in theory questions.
- (d) 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.
- (e) In Q2.1 some candidates were unable to provide the specific measures to be taken when treating an open wound. They stated prevention and contamination of the open wound.
- (f) Q2.2 specifically asked for safety precautions that must be observed *after* the surface grinder has been switched on, instead candidates provided general safety precautions, which included precautions that must be observed before and during the operation of a machine.
- (g) In Q2.6 majority of the candidates could not identify the type of workshop showed in the figure.

Suggestions for improvement

- (a) When using tools and equipment, demonstrate the importance of using surgical gloves when someone cuts himself or herself. Video presentations and demonstrations will give learners an advantage when answering these types of questions on first aid. Also state who is responsible for the administering of first aid.
- (b) 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.
- (c) Learners should be exposed to workshop practice relating to the safety of tools, the equipment in the workshop and the workshop environment.
- (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 Q3.2 the candidates' responses indicated a lack of theoretical knowledge as well as practical application when labelling the drawing about the annealing process.
- (b) In Q3.5 majority of the candidates did not know which quenching media had to be used to harden steel.

Suggestions for improvement

- (a) Learners should be exposed to the different processes to enhance the properties of metal.
- (b) The revision programme must include exercises requiring explanation, definition and application of heat-treatment processes. Schools need to organise educational excursions to foundries or other places where materials are processed in order to acquaint learners with metallurgy and to further improve their understanding of the processes involved.

QUESTION 4: MULTIPLE-CHOICE QUESTIONS

Common errors and misconceptions

- (a) Some candidates did not read the questions carefully.
- (b) The majority of the candidates seem to lack proper skills to answer multiple-choice type questions.
- (c) Most candidates did not know the principle used on an incremental cutter in a CNC milling machine.
- (d) Many candidates seem to lack proper knowledge of the definitions of terminologies regarding *stress*, *strain* and *break stress* and *safety factor*.

Suggestions for improvement

- (a) Learners must be taught the technique of arriving at the correct answer through the process of elimination in instances where they are unable to identify the correct alternative immediately.
- (b) Teachers should explain the main difference between *absolute* and *incremental programming* on a three-axis digital read-out system. A practical demonstration will enhance learners' understanding of this term.
- (c) Teachers should focus on the definitions of all terminology in the subject during informal as well as formal assessment activities.

QUESTION 5: TERMINOLOGY – LATHE AND MILLING MACHINE

Common errors and misconceptions

- (a) Answers to Q5.1 revealed that candidates lacked the mathematical skills required to answer the question.
- (b) Q5.2.2 requested the set-over of the tailstock. Only a few candidates managed to give the correct answer because they required the length of the taper from Q5.2.1.
- (c) Q5.4 was based on the theory of the practical application of skills regarding the milling processes. Candidates who did not perform well could not relate this content to the process in practice.

Suggestions for improvement

- (a) The subject teacher needs to integrate relevant sections with Mathematics (trigonometric equations) and Technical Mathematics.
- (b) Teachers should give learners more weekly activities with different questioning techniques such as substitution, manipulation of formulae and calculations.
- (c) Learners should practise using previous question papers.
- (d) Performing practical tasks can assist learners to understand the concepts, processes and advantages and disadvantages. This should improve the quality of answers to questions.
- (e) Mathematical skills can only improve with practice. Use the steps as suggested:
 - Identify the formula
 - Formula manipulation (if necessary)
 - Substitution (correct values or units)
 - Answer with unit of measure indicated

QUESTION 6: TERMINOLOGY – INDEXING AND DOVETAILS

Common errors and misconceptions

- (a) Q6.2.1 and Q6.2.2 required the candidates to calculate dovetail dimensions and the majority of the candidates could not answer these questions correctly.
- (b) In Q6.3.1 the majority of the candidates did not give the final answers for indexing. There were no full turns and 8 holes on the 28-hole circle and no full turns and 12 holes on the 42-hole circle.
- (c) Q6.3.2 required the candidates to calculate change gears. Unfortunately, very few candidates could perform the calculation.
- (d) Candidates still struggle with basic fraction calculations.

Suggestions for improvement

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

QUESTION 7: TOOLS AND EQUIPMENT

Common errors and misconceptions

- (a) Candidates could not identify the type of tester shown in the figure in Q7.4.
- (b) Q 7.4 was based on the theory of the practical application of skills related to testing of material and measuring skills. The candidates who did not perform well could not make reference to the content in practice.
- (c) Q7.8 required the use on interchangeable rods used in a depth micrometre. This was poorly answered.

Suggestions for improvement

- (a) Teachers should use electronic media and practical exercises to cover the content on testers used to determine specific properties of materials and the application of measuring equipment.
- (b) Learners must know the names and uses of the tools that they are using. Teachers can create practical tasks to improve measuring skills using Vernier callipers, micrometres and accessories.

QUESTION 8: FORCES

Common errors and misconceptions

- (a) In Q8.1 the majority of the candidates ignored the hint provided in the question. There was an improvement in the response to this question, although many candidates struggled with the direction needed in the final answer (north of west) and they incorrectly labelled the horizontal and vertical components.
- (b) Q8.2.2 and Q8.2.3 required reactions at support A and B. Some candidates mixed up the supports.
- (c) Many candidates did not convert to the correct units before and after completing the calculation, as required in the question, e.g. MPa and mm.
- (d) Calculations with exponents in Q8.3 were a great challenge for the candidates. They were unable to state the required units of measure. Furthermore, candidates were not able to work with formulae on stress calculations.

Suggestions for improvement

- (a) Drawing a diagram will assist candidates in determining the direction of the resultant.
- (b) Learners should be encouraged to perform calculations systematically according to the following steps:
 - Identify/Use the correct formula (this may be on the formula sheet)
 - Manipulate the formula, if necessary, depending on the information available
 - Substitution correct values or units, as per the question
 - Express the final answer with the relevant unit of measure
- (c) Learners must ensure that they use exponents and the correct unit in the answer.

- (d) Different methods of calculations should be explored and explained to the learners. Manipulation of formulae should be practised and the meaning of every entity in the formula should be explained in a broader sense.
- (e) Different areas must be practised during homework and assessments.

QUESTION 9: MAINTENANCE

Common errors and misconceptions

- (a) All questions, except Q9.4, Q9.5 and Q9.6, were poorly answered. This has resulted in the overall poor performance in this question. It was evident that this content was not adequately covered, or not at all in some cases.
- (b) This section consists mostly of factual information and most of candidates' responses showed a lack of knowledge and understanding in this topic.
- (c) The majority of the candidates' answers indicated a lack of practical experience in respect to maintenance.
- (d) Most of candidates had difficulty giving a reason or providing an explanation or stating a procedure, when required to do so.

Suggestions for improvement

- (a) Resources on this content are readily available on the internet. It is recommended that teachers make use of videos and other visual resources during the lessons.
- (b) Maintenance procedures cannot be learnt from a book or notes. It has to be observed or performed in practice. Teachers can design practical tasks that involve maintenance procedures. It is advisable that the procedures be listed in point form. It is also important that the correct terminology related to maintenance is taught.
- (c) The integration of theory and practice in the workshop is imperative.

QUESTION 10: JOINING METHODS

Common errors and misconceptions

- (a) The majority of the candidates generally lack mathematical skills that were necessary to answer the questions.
- (b) There was evidence that many candidates did not work systematically through the question. They found it difficult to complete a calculation which had to be applied in a subsequent calculation in order to determine the final answer on the specific question. For example, first calculate *pitch diameter*, then *pitch circumference* and then *helix angle*.
- (c) Candidates lost marks because when the first calculation was incorrect, subsequent calculations would also be incorrect. e.g. 10.2.1 – 10.2.4. (11 marks).

Suggestions for improvement

- (a) Teachers need to make sure that learners know and understand screw thread terminology and advantages.
- (b) Learners should practise calculations more to gain confidence to answer this type of question.
- (c) Learners should work systematically through the calculations according to the following steps:
 - Formula
 - Formula manipulation (if necessary)
 - Substitution (correct values or units)
 - Answer with unit of measure.

QUESTION 11: SYSTEMS AND CONTROL

Common errors and misconceptions

- (a) This question was answered poorly. This was possibly due to the topic being placed towards the end of the year on the ATP and teachers had to cope with the time constraints imposed by Covid-19 protocol, disruptions and load shedding.
- (b) This section was a higher-order section and most candidates struggled with systems and control calculations.
- (c) Q11.1.1 and Q11.1.2 were answered very poorly due to a lack of mathematical skills. Candidates lost marks because when the first calculation was incorrect, subsequent calculations would also be incorrect.
- (d) In Q 11.5.1 and Q11.5.2 many candidates were not able to apply the formulae correctly but also expressed the answer in the incorrect unit of measure.
- (e) In Q11.6 many candidates did not calculate the *product* of the number of gear teeth, they calculated the *sum* of the number of gear teeth, which was not a requirement of the question. This was a common mistake among many candidates.

Suggestions for improvement

- (a) Mathematical skills can only improve with practice. Teachers must create many opportunities to ensure material is always available.
- (b) Learners must work systematically through the calculations according to the following steps:
 - Formula
 - Formula manipulation (if necessary)
 - Substitution (correct values or units)
 - Answer with unit (Pay attention to requirements in the question)
- (c) Practical application of this content will assist the learner in understanding the content. The subject needs to be integrated with Mathematics, Technical Sciences and Technical Mathematics.