CHAPTER 1

TECHNICAL MATHEMATICS

The following report should be read in conjunction with the Technical Mathematics question papers of the November 2018 examinations.

1.1 PERFORMANCE TRENDS (2018)

In 2018, 10 025 learners sat for the Technical Mathematics examination. The performance of the candidates in 2018 cannot be compared to previous years, because 2018 was the first year that this subject was written. The performance at 30% and above was 50,7% in 2018.

Table 1.1.1(a) Overall Achievement Rates in Technical Mathematics

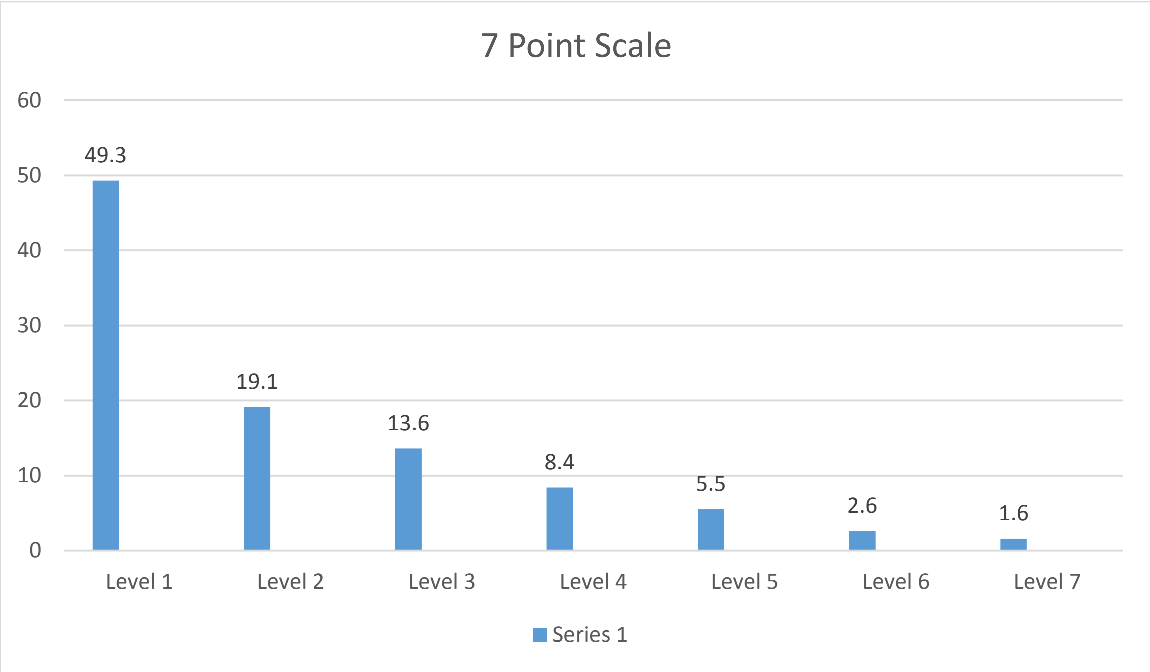
Year	No. wrote	No. achieved at 30% and above	% achieved at 30% and above	No. achieved at 40% and above	% achieved at 40% and above
2018	10 025	5 075	50,7	3 178	31,7

The performance of learners in Technical Mathematics in the 2018 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.

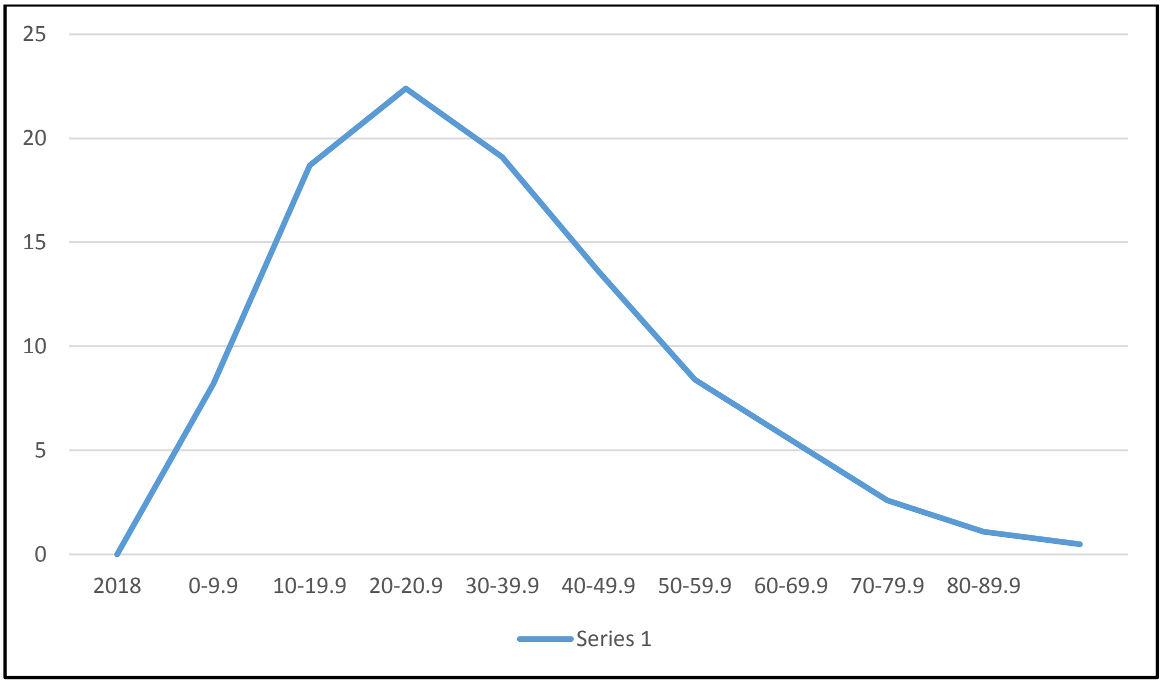
Revision of work from earlier grades will play an integral part in improving performance in the subject. As stipulated in the Technical Mathematics *CAPS*, 'Mathematical modelling is an important focal point of the curriculum' and that 'Real life Technical problems should be incorporated into all sections whenever appropriate.'

Graph 1.1.1(b) Overall Achievement Rates in Technical Mathematics (Percentage)



The above graph is different in content from that in other subjects

Graph 1.1.1(c) Performance Distribution Curve in Technical Mathematics (Percentage)



1.2 OVERVIEW OF LEARNER PERFORMANCE IN PAPER 1

General Comments

(a) Candidates performed relatively well in Q6, Q8 and Q9. These questions were based on Grade 12 topics and the total mark was 44, which constituted approximately 29% of the paper.
(b) In Q1, Q3 and Q7, candidates performed well. These questions were based on topics from Grades 10, 11 and 12 and the total mark was 60, which constituted 40% of the paper.
(c) Questions in which learners performed poorly were Q2, Q4 and Q5. These questions were based on topics from Grades 10 and 11 and the total mark was 46, which constituted approximately 31% of the paper.
(d) Performance in topics taught in earlier grades was poor compared 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.
(e) Higher-order questions were poorly answered.
(f) Questions on interpretation of graphs were not answered in many cases and when answered, the performance was very poor.
(g) Candidates did not read and follow instructions as stipulated in the question paper.
(h) Candidates found it difficult to cope with questions based on integrated topics.

1.3 DIAGNOSTIC QUESTION ANALYSIS OF PAPER 1

Rasch analysis not done in this paper, as result, no data is available.

1.4 ANALYSIS OF LEARNER PERFORMANCE IN EACH QUESTION IN PAPER 1

QUESTION 1: EQUATIONS AND INEQUALITIES (ALGEBRA)

Common Errors and Misconceptions

(a) In Q1.1.1, candidates did not realise that the equation was equated to zero and was already factorised. As a result, many of them multiplied the brackets and could not solve the problem any further.

$-2x(x+a)(3-x)=0$

$-6x^2+2x^3-6ax+2ax^2=0$

In some instances, they correctly wrote down two values of x and omitted $x=-a$

(b) Many candidates failed to write the correct standard form in Q1.1.2, and hence incorrectly substituted values of a, b and c in the quadratic formula.

(c) Some candidates confused inequalities with equations and they failed to represent their solutions on a number line in Q1.1.3.

(d) Q1.2 was a modelling question (contextual question), and candidates did not conclude that $y \neq -5$

(e) In Q1.4, candidates omitted base 2.

Suggestions for Improvement

(a) Teachers need to emphasise the difference between the equation that is already factorised and equated to zero, i.e. $(x-1)(x+2)=0$ and the one with the other side factorised and not equal to zero $(3x-1)(x+2)=5$

Integrate topics where possible, like in this case where the question required three solutions as it is the case with solving third degree polynomials.

(b) Learners should always be taught to write the quadratic equation in the form $ax^2+bx+c=0$.

(c) Revision of linear inequalities and their graphical representations needs to be done to avoid misconceptions in quadratic inequalities. Teachers need to emphasise correct use and interpretation of '**OR**' and '**AND**'.

(d) Technical Mathematics learners should be exposed to real-life technical problems so that they can draw valid conclusions based on the scenario given.

(e) Teachers should emphasise the importance of writing the base 2 when presenting binary numbers.

QUESTION 2: NATURE OF ROOTS

Common Errors and Misconceptions

(a) Many candidates substituted the given values of q and solved for x instead of describing the nature of roots in Q2.1.

(b) Candidates in Q2.2 failed to write the correct standard form and ended up making p the subject and used the quadratic formula to solve for p. Many candidates failed to interpret the nature of roots conditions.

Suggestions for Improvement

(a) Teachers should relate the discriminant $\Delta = b^2 - 4ac$ to the quadratic formula $x = \dfrac{-b \pm \sqrt{b^2 - 4ac}}{2a}$, i.e. $x = \dfrac{-b \pm \sqrt{\Delta}}{2a}$, thus what is under the radical sign can be used to describe the nature of roots.

(b) Teachers need to expose learners to application questions involving nature of roots.

QUESTION 3: EXPONENTS, SURDS, LOGARITHMS AND COMPLEX NUMBERS

Common Errors and Misconceptions

(a) Many candidates, in Q3.1.1, could not apply the law of exponents. They omitted raising 2 to the exponent 3, $\left(2a^{\frac{7}{3}}\right)^3 = 2\left(a^{\frac{7}{3}}\right)^3$

$$= 2a^7$$

(b) Some candidates, in Q3.1.3, used a calculator against the given instructions and wrote the answer only.

(c) In Q3.2, many candidates did not understand the logarithmic laws. Several candidates assumed values of x and applied a 'trial and error' method to solve the equation.

(d) Most of the candidates, in Q3.3, wrote reference angle as negative and used it in the polar form without considering the relevant quadrant. In addition, many candidates did not write the answer in the required polar form.

(e) Some candidates could not expand $(2 - 3i)^2$ in Q3.4.

Suggestions for Improvement

(a) Revision of exponential laws from Grade 8 needs serious attention.

(b) Teachers should emphasise the adherence to given instructions by learners. This can be enhanced in both informal and formal assessment tasks, where instructions are clearly indicated. Teachers need to strengthen the concept of prime factors done in Grade 8.

(c) Teachers need to revise log definitions and laws done in Grade 11.

(d) Teachers should teach learners that the reference angle must be positive, and the required angle can be determined by looking at the quadrant in which the trig ratio is negative (as in the question paper) or positive.

(e) Teachers need to advise learners to expand squared expressions and apply distributive law of multiplication to simplify, i.e. $(2-3i)^2 = (2-3i)(2-3i)$

QUESTION 4: FUNCTIONS

Common Errors and Misconceptions

(a) In Q4.1.1, many candidates wrote only the horizontal asymptote, $y=-1$ and omitted the vertical asymptote $x=0$.

(b) Many candidates could not sketch the correct graphs in Q4.1.3.

(c) In Q4.1.5 and Q4.1.6, candidates did not understand the meaning of domain and range. They wrote specific values of x and y. They failed to write the solution in interval form.

(d) Candidates incorrectly assumed the values of R without doing calculations to justify their answers in Q4.2.2.

(e) In Q4.2.4, most candidates used the given function which was supposed to be proved.

(f) Interpretation of functions is a major challenge. Candidates wrote a specific value of x and not the interval. Some candidates who could find the solution did not consider the restriction $x<0$.

Suggestions for Improvement

(a) It should be indicated to learners that the hyperbola is written in the form $f(x)=\frac{a}{x}+q$ as prescribed in Technical Mathematics *CAPS*, then leaners need to know that the vertical asymptote will always be $x=0$.

(b) 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.

(c) Definition of domain and range should be thoroughly explained to learners.

(d) Learners should be taught to always find the values of the points they are going to use in answering questions and not assume them. Learners must first calculate the coordinates if they are not given.

(e) Leaners need to be taught that, when the question says 'show/prove that', it actually says, calculate (justify by means of mathematically correct steps) what is given and the answer must be as stated.

(f) Teachers should indicate to learners that $f(x)\times g(x)>0$ means the interval where both graphs are above the $x-$axis or both are below the $x-$axis. More activities of this nature must be given to learners.

QUESTION 5: FINANCE, GROWTH AND DECAY

Common Errors and Misconceptions

(a) Many candidates calculated *effective interest rate* instead of *nominal rate* in Q5.1.

(b) In Q5.2.2, some candidates swapped the values of A and P and many could not make *n* the subject of the formula.

(c) In Q5.3 many candidates substituted incorrect values of i and n for the first 4 years of the investment. The statement indicated that the interest is compounded quarterly but candidates treated it as compounded annually.

Suggestions for Improvement

(a) Teachers should teach conversion of nominal interest rate to effective interest rate and vice versa.

(b) Teachers need to indicate to learners that when the scenario is addressing depreciation, the value of P will be greater than the value of A, whereas in the appreciation scenario, the value of P will be less than the value of A.

Revision of the conversion of an exponential equation to log form $\left(a^c = b \Rightarrow \log_a b = c\right)$ in finance must be done before learners are taught to calculate the value of n.

(c) Teachers should teach all compounding periods of interests (compounded annually, seasonally/quarterly, monthly, semi-annually/half-yearly, and even daily). It is always important to use time-lines to demonstrate investments and withdrawals.

QUESTION 6: CALCULUS

Common Errors and Misconceptions

(a) In Q 6.1, some candidates:

- Wrote the incorrect notation by omitting $\lim\limits_{h\to 0}$ when applying first principles, i.e.

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

$$= \frac{7(x+h)-2-(7x-2)}{h}$$

- Could not correctly substitute in the formula.
- Omitted brackets when substituting $f(x)$
- Wrote $\lim\limits_{h\to 0} = \dfrac{f(x+h)-f(x)}{h}$
- Wrote $f(x) = \lim\limits_{h\to 0}\dfrac{f(x+h)-f(x)}{h}$

(b) In Q 6.2.1, candidates differentiated π^2 as 2π. Candidates did not notice that π^2 is a constant.

(c) In Q6.2.2, most candidates failed to convert surd form to exponential form, i.e. $\sqrt[3]{x} = x^{\frac{2}{3}}$.

(d) Some candidates failed to simplify the equation in Q6.2.3. Candidates divided only x^5 by x^2 and did not divide by 2.

(e) Generally, candidates did not write the correct notation and integrated instead of differentiating in Q6.2.

(f) In Q6.3.3, many candidates assumed another point that was not given and used it with coordinates of A to determine the equation of a tangent.

Suggestions for Improvement

(a) Teachers should emphasize to learners that whenever first principle is used, $\lim\limits_{h \to 0}$ must be written and should only be left out when writing the final answer. Simplification of expressions from Grades 8 and 9 needs to be revised.

(b) Teachers should explain to learners that the notation $\frac{d}{dx}$, means differentiating with respect to x and therefore any term that does not have x is a constant.

(c) Converting surds to exponential form should be adequately done from Grade 10.

(d) Simplification of fractions from Grade 9 should be revised.

(e) Teachers should emphasise the importance of notations $\left(f^{/}(x) \text{if } f(x) = x^n \,,\, \frac{d}{dx}\left(x^n\right), D_x\left(x^n\right)\right), \frac{dy}{dx} \text{ if } y = x^n$ when teaching calculus and clearly differentiate between *derivative* and *integrals***.**

(f) Teachers should first define a derivative when introducing Calculus, i.e. before applying the concept. The definition of derivative explains very well that it is the gradient of a tangent to a curve, instantaneous rate of change, gradient at any point.
If well explained, then learners will understand that whenever they see a question asking the gradient of a tangent, they need to differentiate and that will lead to determining the equation of a tangent. The only point to be used to determine the equation a tangent is a point of contact of the tangent and the curve.

QUESTION 7: CUBIC FUNCTION

Common Errors and Misconceptions

(a) In Q7.1, candidates did not write the answer in coordinate form as required in the question.

(b) Most candidates used the given function which was supposed to be proved in Q7.3.

(c) Some candidates first multiplied the right-hand side with negative and then differentiated in Q7.4, and that ultimately changed the shape of the graph.

$f(x) = -x^3 + 6x^2 - 9x$

$f(x) = x^3 - 6x + 9x$

Other candidates used $x = -\frac{b}{2a}$ to determine the coordinates of the turning points.

Some candidates did not equate the derivative to zero.

(d) The shape of the graph drawn by many candidates in Q7.5 was affected because of wrong turning points in Q7.4.

(e) In Q7.6 candidates could not identify the correct interval where the graph is increasing, and as a result, the notation and critical values were incorrect.

Some candidates who identified the correct interval where the graph is increasing, failed to write the correct notation.

Suggestions for Improvement

(a) Teachers should emphasise to learners to follow instructions.

(b) Leaners need to be taught that, when the question says 'show that', it actually means, calculate (justify by means of mathematically correct steps) what is given and the answer must be as stated.

(c) Teachers should make learners aware that whenever they change the sign of the right-hand side in a function, they are giving a completely different function to the one given, that can only be correct when determining the x- intercept(s) since $y = f(x) = 0$

Teachers should indicate to learners that $x = -\frac{b}{2a}$ applies only to quadratic functions and not cubic functions.

Teachers need to emphasize that at the turning points, the derivative equals to zero.

(d) Teachers should advise learners to use the table method to draw graphs.

(e) Interpretation of functions needs serious attention. Teachers should explain the maxima and minima and demonstrate to learners where the graph is increasing, constant and decreasing with the aid of diagrams. The use of software, like Geometry Sketch Pad and Graph as well as GeoGebra, can be useful for teaching functions.

QUESTION 8: APPLICATION OF CALCULUS

Common Errors and Misconceptions

(a) Many candidates did not write the bracket for $(1-x)$ when they substituted in the volume formula $v = 1,5 \times 3x \times 1 - x$ in Q8.1.1.

(b) In Q8.1.2, some candidates equated the volume expression to zero and solved for x instead of differentiating and equating the derivative to zero and solving for x.

(c) Some candidates equated the velocity function to zero in Q8.2.1.

(d) In Q8.2.3 many candidates directly substituted time in the velocity function instead of differentiating and then substituting the time value.

Suggestions for Improvement

(a) Teachers need to teach learners that the use of brackets is important when substituting with a value with more than one term especially when multiplication will be done.

(b) Teaching of maxima and minima must always be integrated with graphs.

(c) Teachers should explain that at the starting point (initial), time is zero.

(d) Derivative is also defined as the instantaneous rate of change. Teachers should pay special attention to the definition of a derivative.

QUESTION 9: INTEGRATION

Common Errors and Misconceptions

(a) Some candidates omitted C on indefinite integrals in Q9.1.1 and 9.1.2.
After integrating, they still wrote the integration notation.

$$\int\left(-\frac{6}{x}\right)dx$$
$$= \int -6\ln x$$

(b) Some candidates did not write the correct expansion in Q 9.1.2, instead they wrote $(x-1)^2 = x^2 + 1$.

(c) In Q9.2, candidates swapped the lower and upper limits of definite integrals.
$\int_1^{-2}(x^2+3)\,dx$ instead of $\int_{-2}^{1}(x^2+3)\,dx$.

(d) Generally many candidates wrote notations incorrectly in Q9.

Suggestions for Improvement

(a) Teachers should explain that in indefinite integrals, C must always be added and use of the correct notion should be emphasised.

(b) Revision of Grade 9 products needs to be done.

(c) Teachers should indicate to learners that in definite integrals, the upper limit is always greater than the lower limit.

(d) Teachers should emphasise the importance of correct notation when teaching integration.

1.5 ANALYSIS OF LEARNER PERFORMANCE IN EACH QUESTION IN PAPER 2 2

(a) Candidates performed relatively well in Q1. This question was based on topics from Grades 10 and 11 and the total mark was 13, which constituted approximately 13% of the paper.

(b) Candidates performed well in Q2, Q3, Q10 and Q11. These questions were based on work from Grades 10, 11 and 12 and the total mark was 61. 58 out of 61 marks were on work done in Grades 10 and 11 which constituted approximately 39 % of the paper.

(c) Questions in which learners performed poorly were Q4, Q5, Q6, Q7, Q8 and Q9. These questions were based on work done in Grades 10, 11 and 12 and the total mark was 76. 53 of the 76 marks were on work done in Grades 10 and 11 which constituted approximately 35 % of the paper.

(d) Based on the question by question analysis, candidates performed relatively well on the content from Grades 10 and 11 in analytical geometry and mensuration.

(e) The general performance of candidates in Grade 12 work was very poor.

(f) The total mark for the paper was 150, of which 124 marks (which constituted approximately 83% of the paper) assessed topics from Grades 10 and 11.

(g) Candidates generally wrote incorrect formulae which could be attributed to not using the formula sheet.

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

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

1.6 DIAGNOSTIC QUESTION ANALYSIS FOR PAPER 2

Rasch analysis not done in this paper and therefore no data is available.

1.7 ANALYSIS OF LEARNER PERFORMANCE IN EACH QUESTION IN PAPER 2

QUESTION 1: ANALYTICAL GEOMETRY

Common errors and misconceptions

(a) In Q1.1, candidates did not follow the instructions. The answer was left as $\sqrt{41}$ instead of 6,4.

(b) Candidates copied the midpoint formula incorrectly from the formula sheet in Q1.2, i.e. $\mathrm{M}\left(\frac{x_2 - x_1}{2};\frac{y_2 - y_1}{2}\right)$.

(c) Many candidates assumed the coordinates of points C and D to determine gradient in Q 1.3. Candidates' gradient value was negative though the line was increasing.

(d) Candidates' angle measure was obtuse though it was illustrated as acute in the diagram in Q1.4. Many candidates did not use the angle of inclination formula correctly, instead they wrote $m = \tan\frac{4}{5}$.

(e) Candidates substituted points (C & D) that were not on the line OA in Q1.5 and hence the incorrect equation of the line OA was calculated. Substitution, working with fractions and applying the distributive property of multiplication were challenging for candidates.

Suggestions for improvement

(a) Teachers should always emphasize the importance of adherence to instructions.

(b) Teachers need to allow learners to use formula sheets in informal and formal assessments in Grade 12 so that learners may become familiar with it.

(c) Learners should be taught to always find the values of the points they are going to use to answer questions and not assume them. Learners must first calculate the coordinates if they are not given. Teachers should adequately revise linear graphs and their characteristics. Teaching of analytical geometry should not be isolated from linear functions done in Grade 9.

(d) The relationship between the angle of inclination and the gradient must be emphasised.

(e) Basic algebraic skills and knowledge must be practised and drilled in lower grades. Algebraic manipulation is a skill that candidates need to master. The effective use of the calculator will also assist learners in simplifying fractions.

QUESTION 2: ANALYTICAL GEOMETRY

Common errors and misconceptions

(a) Candidates were unable to relate the given information with the sketch in Q2.1.1. Manipulation to answers after correct substitution was poorly executed by some candidates.

(b) Some candidates could determine the correct value of the intercept in Q2.1.2, but wrote it as x and not y. It therefore suggests that candidates did not know that K is the y-intercept of line KL and therefore the value of x is 0.

(c) Candidates did not use the fact that parallel lines have equal gradients in Q 2.1.3. The point M was not used in the solution to determine the equation of the straight line in many cases.

(d) Candidates did not use analytical methods, as instructed in Q2.1.4. A number of candidates used Euclidean Geometry and stated that the tangent KL is perpendicular to the radius LM (tangent⊥ radius or KL ⊥ OL or KL ⊥ ML).

(e) Some candidates were unable to calculate the coordinates of the intercepts in Q2.2. Some used 9 and 25 as the x and y - intercepts, respectively.

Suggestions for improvement

(a) Teachers should expose learners to questions where alternative methods are used to calculate the coordinates of points. Learners should be exposed to questions that require them to solve by substitution.

(b) Basic graph knowledge and skills must be practised and consolidated. Interpretation of graphs should be emphasized.

(c) Relationship of parallel lines, perpendicular lines and the equation of the line passing through a point should be emphasized during teaching.

(d) The use of specific instructions (methods) described in questions, should also be adhered to.

(e) Learners should be taught that the intercepts are square roots of the denominators of x^2 and y^2. They should be able to determine the major and minor axis.

QUESTION 3: TRIGONOMETRY

Common errors and misconceptions

(a) The incorrect application of the theorem of Pythagoras and distance formula was evident in Q3.1.1.

(b) Candidates wrote incorrect values of trigonometric ratios in Q3.1.2, Q3.1.3 and Q3.2.

(c) In Q 3.2, the use of a calculator to evaluate reciprocal trigonometric ratios and rounding skills was a challenge.

(d) Many candidates did not realise that the question was a follow up of Q.3.3.1. Some candidates failed to identify the correct quadrant.

Suggestions for improvement

(a) Learners should be exposed to working with points in different quadrants of the Cartesian plane. They should also be able to draw a rough sketch of a right-angled triangle given a point in any quadrant and then apply the theorem of Pythagoras and distance formula properly.

(b) Teachers should revise trigonometric ratios as done in Grade 10.

(c) Basic calculator skills should be practised. Rounding off should be mastered from earlier grades.

(d) Teachers need to revise the identification of correct quadrants were ratios are positive or negative and hence be able to determine angles. When solving trigonometric equations, teachers should link this to the basic trigonometric graphs to improve on the conceptual understanding of this concept.

QUESTION 4: TRIGONOMETRY

Common errors and misconceptions

(a) Some candidates wrote incorrect signs when doing reductions in Q 4.1.
Many candidates wrote incorrect reciprocals (cot, sec and cosec).

(b) Some candidates wrote down incorrect fundamental identities. Once again, the asked identity involved reciprocals and many candidates could not complete the identity asked in Q4.2.

(c) Many candidates in Q4.3 did not know the value of $\cos\pi$. They could not connect radians with degrees.

Suggestions for improvement

(a) Teachers should revise reduction formulae and reciprocals.

(b) Teachers should revise fundamental identities.

(c) Radian measures must also be used and integrated with degrees so that candidates are able to convert between the two measures.

QUESTION 5: TRIGONOMETRIC FUNCTIONS

Common errors and misconceptions

(a) Candidates were unable to draw the graphs of $f(x) = \tan x$ and $g(x) = \sin 2x$ in Q5.1. Many struggled with the shape as they were unsure of the location of the x-intercepts of $g(x) = \sin 2x$. The endpoints of the graph of f was also not clearly indicated. Candidates did not observe the domain of the graphs. The critical values on the graphs were also omitted. Candidates did not consider the given interval of $x \in [0°; 180°]$ as most graphs were drawn in an interval of $x \in [0°; 360°]$.

(b) Candidates wrote incorrect critical values and notation for the range in Q5.2.

(c) In Q5.4, candidates were unable to identify the correct interval. In some cases, random values for x were chosen, which did not make any sense.

Suggestions for improvement

(a) When teaching trigonometric graphs, teachers should first start with the basic functions: $y = \sin x$, $y = \cos x$ and $y = \tan x$ identifying important features and characteristics of these graphs. The next step is to introduce the parameters a, p and q.

(b) Teachers should emphasize features and characteristics of functions and thoroughly define domain and range.

(c) Interpretation of graphs should be taught thoroughly and be included in both informal and formal assessment tasks so that candidates are well prepared to answer any question in trigonometric graphs.

QUESTION 6: TRIGONOMETRY

Common errors and misconceptions

(a) Many candidates used AB = 13 as their point of departure, yet that was what they were supposed to prove in Q6.1. Most candidates could not apply the sine and cosine rule correctly.

(b) Some candidates were not able to apply the Pythagoras theorem correctly in Q6.2. Some even used wrong triangles. The instruction 'round to the nearest metre' was ignored by some candidates.

(c) Some candidates used the sine rule instead of the cosine rule in Q6.3.

Suggestions for improvement

(a) Leaners need to be taught that, when the question says 'show/prove that', it requires them to calculate (justify by means of mathematically correct steps) what is given and the answer must be as stated.

(b) The Pythagoras theorem should be thoroughly taught and applied in different contexts.

(c) Three dimensional problems must be taught and assessed so that learners can identify triangles and rules thereof to be used to solve any problem. 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 in Q7.1 to Q7.3. Candidates lacked the basic knowledge of the properties of triangles and quadrilaterals and their applications.

Suggestions for improvement

(a) During the teaching of Euclidean geometry, teachers should regularly give learners activities on stating theorems.

(b) The 'accepted reasons' as stated in the examination guidelines must be consolidated and reinforced when teaching Euclidean geometry. These reasons must be linked to circle geometry theorems with sketches to reinforce concepts. Teachers should cover the basic work thoroughly. An explanation of the theorem should be accompanied by showing the relationship in a diagram.

QUESTION 8: EUCLIDEAN GEOMETRY

Common errors and misconceptions

(a) Candidates named the angles in Q8.2.1 incorrectly.

(b) Candidates were unable to apply the converse theorems (of cyclic quadrilaterals).

Suggestions for improvement

(a) Teachers should expose candidates to different ways of naming angles in the lower grades.

(b) Teachers should explain the difference between a theorem and a converse. Application of converse theorems should be known and practised in solving riders.

QUESTION 9: EUCLIDEAN GEOMETRY

Common errors and misconceptions

(a) Some candidates were unable to apply the proportion and similarity theorems in Q9.2.1 and Q9.2.2(a). Candidates were unable to differentiate between similarity and congruency. They were also unable to give the correct reason when applying these theorems.

(b) Some candidates considered components of ratios as the actual lengths of the sides in Q 9.2.2 (b). i.e. $\text{KQ} = 3\ \text{units and QM} = 2\ \text{units}$.

Suggestions for improvement

(a) Teachers should explain proportionality and similarity theorems thoroughly and give learners practice at providing correct reasons for the statements they make. Teachers are encouraged to use different resources. Reasons must be stated according to the 'acceptable reasons' as stated in the Examination Guidelines.

(a) Teachers should thoroughly explain the concept of ratio done in Grade 9. Teachers need to explain the difference between the length and the ratio of the lengths.

QUESTION 10: CIRCLES, ANGLES AND ANGULAR MOVEMENT

Common errors and misconceptions

(a) Candidates had trouble in making conversions i.e. from metres per minutes to metres per second and from degrees to radians in Q10.1.1 and Q10.2.2(b).

(b) Many candidates failed to construct line EG in order to apply the theorem of Pythagoras to determine the radius of the bigger pulley in Q10.2.2 (a).

(c) Many candidates failed to calculate the length of the arc AF and therefore failed to calculate the total length of the belt in Q10.2.2(c).

Suggestions for improvement

(a) All conversion should be emphasized during teaching and assessment.
(b) Teachers should expose learners to more contextual questions that require higher-order thinking.
(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.

QUESTION 11: MENSURATION

Common errors and misconceptions

(a) In Q11.1.2, many candidates did not identify the correct formula from the formula sheet.
(b) Many candidates used the wrong formula to calculate the surface area of a closed cylinder in Q11.2.1 while it was an open cylinder.

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 (especially grade 9).