EXAMINATIONS AND ASSESSMENT CHIEF DIRECTORATE
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2019 NSC CHIEF MARKER'S REPORT

SUBJECT:		**TECHNICAL MATHEMATICS**
PAPER:		**2**
DURATION OF PAPER:		**3 hours**
DATES OF MARKING:		**30 Nov – 12 December 2019**

SECTION 1: (General overview of Learner Performance in the question paper as a whole)

The number of Eastern Cape candidates that wrote the final paper NSC Technical Mathematics 2019 paper increased by 68 learners to 1460.

The number of registered candidates was 1832, thus 372 opted for the Multiple Examination Opportunity (MEO).

The bulk of the learners achieved at level 1 (less than 30%) for this paper.

On top of this are the many centres that achieved zero percent pass for this paper.

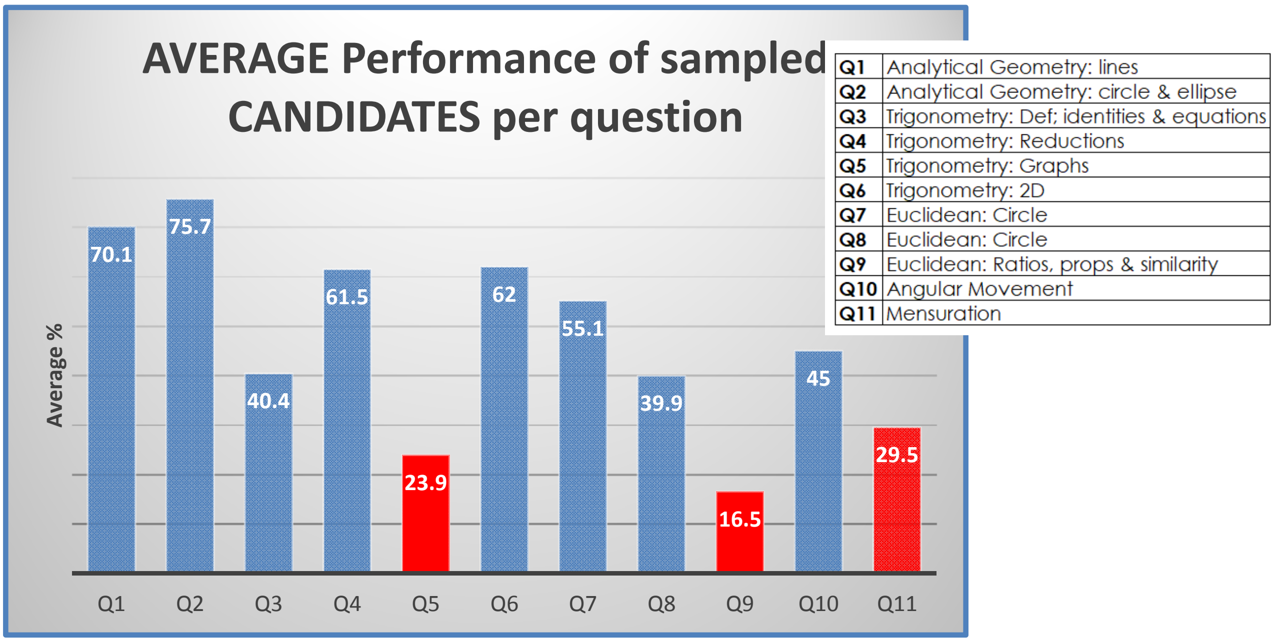
Yes, the numbers have increase, but the necessary results do not show.

A sample of 100 scripts was collected during the marking process. The some of the selected scripts were moderated by the Internal Moderator and/or Chief Marker, and/or the Senior Marker as well as some scripts were unmoderated.

The sample of the candidates is depicted in the next table.

	[0; 44]	[45; 59]	[60; 74]	[75; 89]	[90; 104]	[105; 119]	[120; 150]	TOTAL
Required	15	15	20	20	20	5	5	100
Actual	15	20	24	21	13	6	1	100
Percentage	15%	20%	24%	21%	13%	6%	1%	
	LOW		MEDIOCRE			HIGH		

The following figure summarises the performance of these candidates.



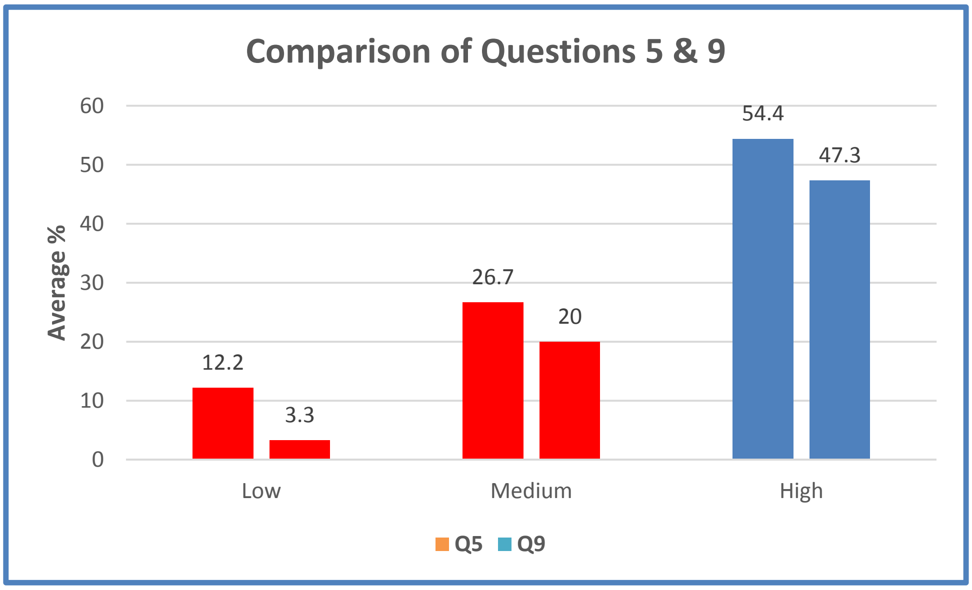
The best performing questions were Questions 1 and 2. They outperformed the other questions by more than 9%. It is however surprisingly as well as sad that there were learners that achieved a zero for this paper.

A dedicated candidate that was taught as required, and with additional support where needed, should have achieved 79% all together in Question 1 and 2, giving such a candidate a minimum of 19 out of 24 marks.

The same as in 2018 Question 9 (Proportion and similarity of Euclidean Geometry) was the worst performing question. Question 5 (Trigonometry graphs) also performed poorly. Question 11 was the surprise underperforming question. Only the last part of Question 11 which deals with surface area and volumes was expected to be a challenge for the candidates, but many made silly mistakes across the question.

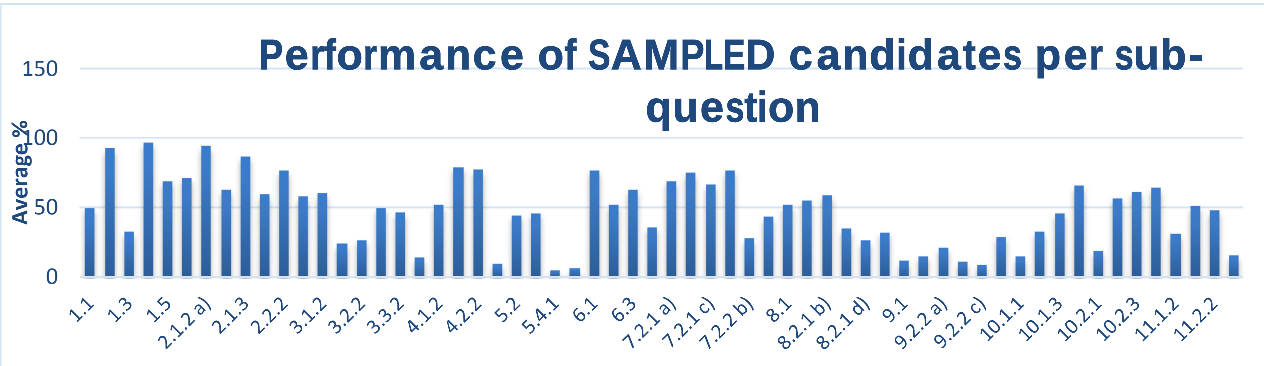
Many candidates did not attempt many of the questions. Most attempted the first two questions.

The following graphs illustrate the performance of sampled candidates in the Questions 5 and 9 only



This confirms that the bad performance Trigonometry graphs and Proportions in Euclidean geometry with the majority of the learners.

The following diagram depict the performance of the sampled candidates across sub-questions



It is recommended that this report be read in conjunction with the NSC November 2019 Technical Mathematics Paper two, since references are made to specific question or sub-questions.

SECTION 2: Comment on candidates' performance in individual questions

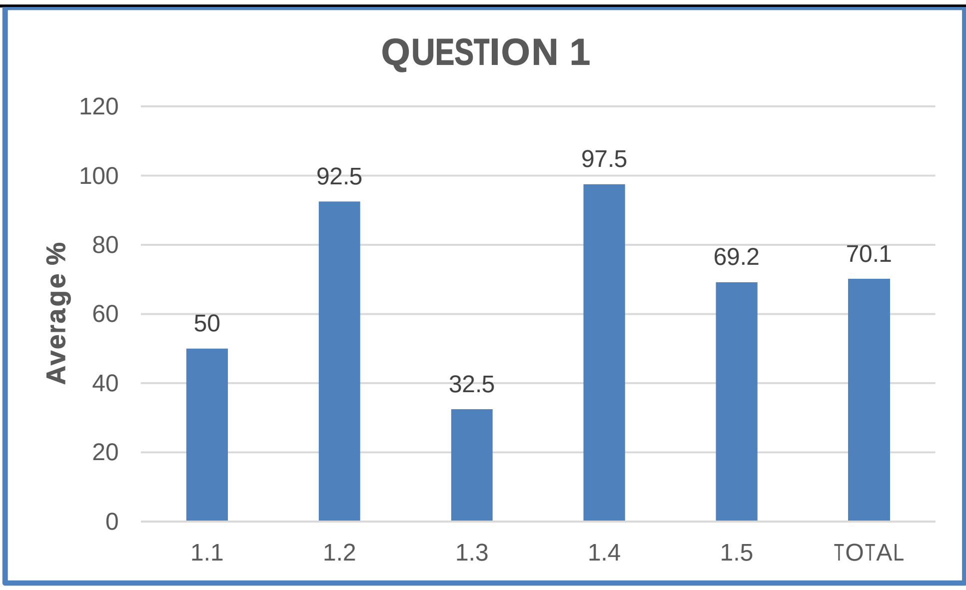
(It is expected that a comment will be provided for <u>each question</u>).

The report will attempt to answer the following question per examination question:

- **a)** General comment on the performance of learners in the specific question. Was the question well answered or poorly answered?
- **b)** Why the question was poorly answered? Also provide specific examples, indicate common errors committed by learners in this question, and any misconceptions.
- **c)** Provide suggestions for improvement in relation to Teaching and Learning
- **d)** Describe any other specific observations relating to responses of learners and comments that are useful to teachers, subject advisors, teacher development etc.

QUESTION 1 [Total marks 12]

- An easy question to ease candidate nerves
- Average % of 70,1 for this question
- However, only 7% of sample candidates scored full marks for this question
- The Distance formula in Q1.2 and application of the midpoint formula in Q1.4 were the best answered question of the sampled candidates.
- Q1.1 was surprisingly poorly answered
- Q1.3 where they must use inclination angle was poorly answered with an average of 32,5%; 29% of sampled candidates scored full mark in this sub-question
- Q1.5 - It's encouraging to see that candidates can determine the equation of a straight line.



Common errors and misconceptions

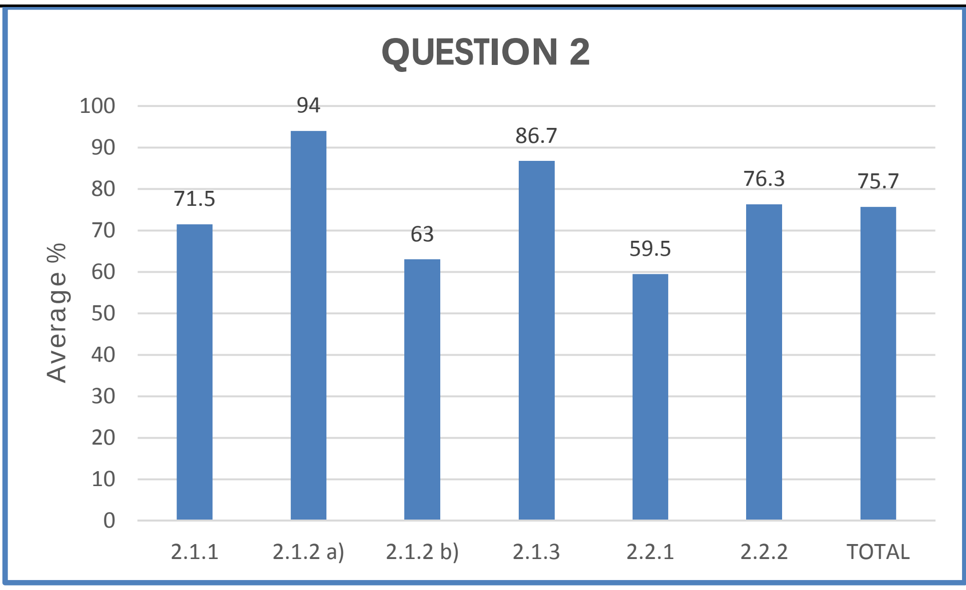
i.) Q1.1 - Many candidates assumed $\propto = 76°$; this is a grade 10 concept that learners could not apply

ii.) Q1.3 - Many candidates did not realise it's the angle of inclination that they must calculate. Further those that did, did not leave their answer as an integer, prohibiting from scoring full marks for this question

iii.) Q1.4 – many learners messed up with substitution of coordinates

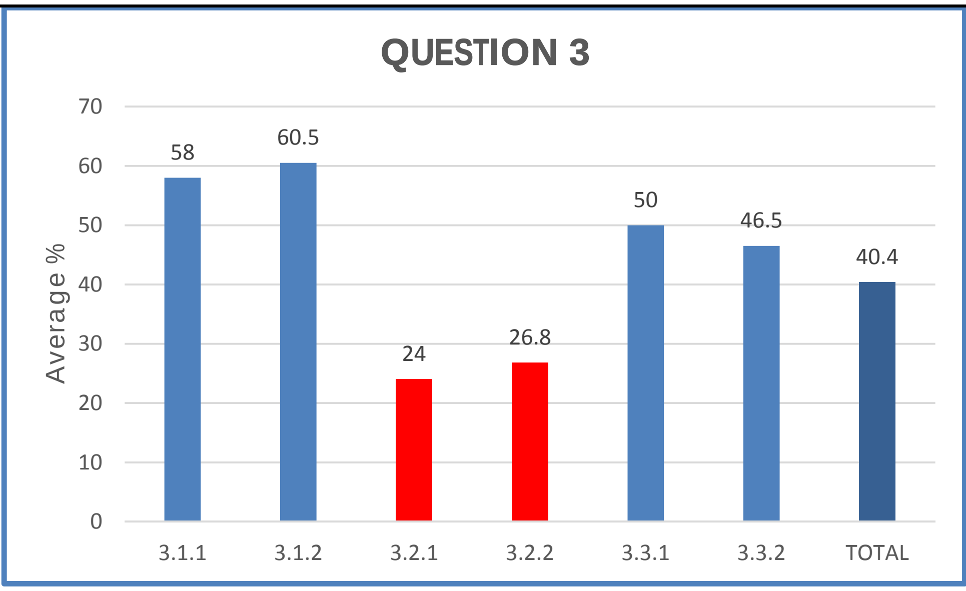
iv.) Q1.5 - Many lost the mark for the gradient of the perpendicular line or for not writing down the equation. Many did not substitute the midpoint calculate in (1.4) into the required equation.

Suggestions for improvement
i.) Basic Euclidean Geometry skills are lacking and need to be focus on

QUESTION 2 [Total marks 12]
• Best answered question for the paper • 24% of sampled candidates scored full marks • Q2.1.3 - Most candidates that could answered Q1.5 did well in this equation • Determining the equation of a straight line counted 8 marks for this paper (5%).

Common errors and misconceptions
i.) Q2.1.1 - Many calculate $r^2 = 25$ correctly, but did not write it as in an equation ii.) Q2.1.2 b) many candidates attempted to find the gradient using the formula not realising that the equation of MN was given and MN ∥ PQ iii.) Q2.2.1 - Good performance in this question – few candidates caught out writing the 32 into a surd, although candidates were able to sketch the graph and leaving the x-intercepts in surd form!
Suggestions for improvement
i.) Calculator usage seems a challenge ii.) Learners must be exposed to different ways of determining the gradient (formula, parallel and perpendicular lines, and inclination) iii.) Teachers must expose learners to different variations of asking to draw the ellipse as well given the ellipse to determine the equation of the ellipse.

QUESTION 3 [Total marks 16]

- No sampled candidate scored full marks for the question
- Q3.2 was the worst sub-question answered, only 2% of sampled candidates scored $\frac{6}{7}$



Common errors and misconceptions

i.) Q3.1.1 - This is a straight-forward calculator usage problem that many learners messed up, 12% - some calculate (sin 3)×(32) instead of sin 96°

ii.) Q3.1.2 - The first mark for the identity was achieved, but the calculator usage is a challenge

iii.) Q3.2.1 - Many candidates were not exposed to this type of questioning – they could not calculate the hypotenuse correctly. Many simplified $r=\sqrt{m^2+1}$ incorrectly to $r=\sqrt{m+1}$

iv.) Q3.2.2 - Candidates could not convert from radians to degrees and therefore could not use the reductions identities

v.) Q3.3.1 - Too many candidates transposed the 2 incorrectly, giving it as $\cos\theta+\sin\theta=-2$

vi.) Q3.3.2 – Many calculated only one angle. Some indicated that the reference angle = $-63,43°$, than drawing the angle in the 4th quadrant and determined that as the only answer.

Suggestions for improvement

i.) Many teachers did not teach this type of question as in question Q3.2.1 – the sketch was given this time, next time the statement was might be given only and the learners will be required to draw the sketch.

ii.) Convert from radians to degrees the learner must multiply by $\frac{180°}{\pi}$ e.g.

$$\frac{29\pi}{36}\times\frac{180°}{\pi}=145°$$

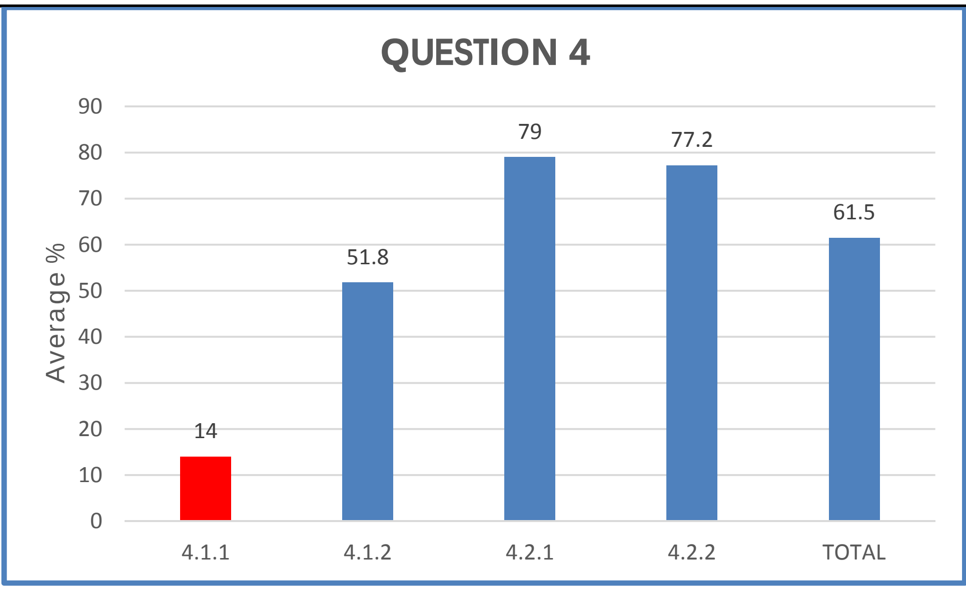
iii.) Reference angle is always positive and acute than the CAST diagram must be applied to determine the possibilities of the required angle

iv.) Teachers and learners are reminded that in grade 12 they are tested on ALL work done in

ALL grades and, in particular grade 10 to 12.

QUESTION 4 [Total marks 12]

- Only one sampled candidate managed to achieve full marks for this question
- Overall performance of the sample candidates was satisfactory
- Q4.1.1 is the worst performing sub-question with only 14% answering the identity correctly
- Only 7 sample candidates achieving level 1 for the paper could correctly calculate sec 60°



Common errors and misconceptions

i.) Q4.1.1 – many candidates indicated the answer to be 1 instead of -1. Others wrote down the reciprocal identities but could not go further

ii.) Q4.1.2 – still there are candidates that did not know that cos 2π =1; furthermore, after applying the identities, they struggled to simplify the expression

iii.) Q4.2.2 – many lost out on the signs of the reduction of the identity

Suggestions for improvement

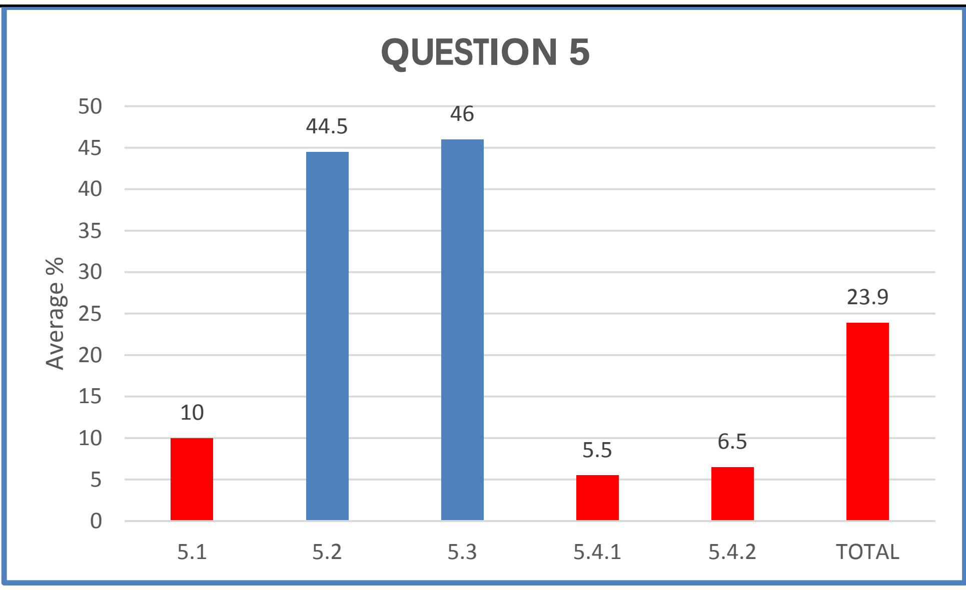
i.) Emphasise the following identities: $1+\tan^2\theta=\sec^2\theta$ and $\cot^2\theta+1=\mathrm{cosec}^2\theta$ as well as their equivalent forms, e.g. $\sec^2\theta-1=\tan^2\theta$ as well as $\sec^2\theta-\tan^2\theta=1$

ii.) Similarly, $\cot^2\theta-\mathrm{cosec}^2\theta=-1$, which was amended to $\cot^2 2\beta-\mathrm{cosec}^2 2\beta=-1$ in the question paper. A similar question was asked in 2018.

iii.) Teachers must exposed learners to more exercises where learners have to prove the LHS = RHS with all of the identities mentioned above

QUESTION 5 [Total marks 09]

- None of the sampled candidates scored full marks
- Only 34% of sampled candidates passed this question
- Q5.1 – only 10% got the period of the graph correct
- Q5.2 – only 26% of the candidates could calculate *a* and *b* correctly
- Q5.3 – only 18% could determine the coordinates of T
- Q5.4.1 – only 4% could read off the inequality correctly
- Q5.4.2 – only 5% could correctly identified where $\frac{f(x)}{g(x)}$ is undefined and only 7% could score a mark or more



Common errors and misconceptions

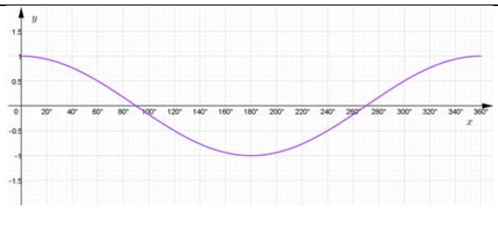
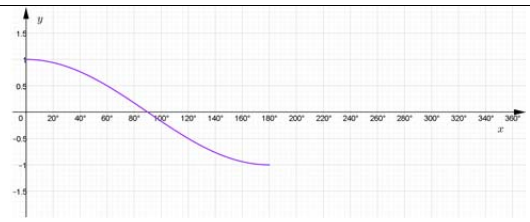
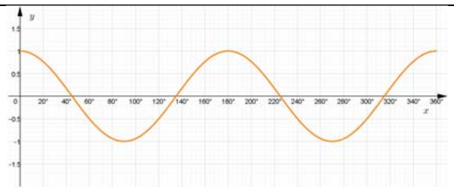
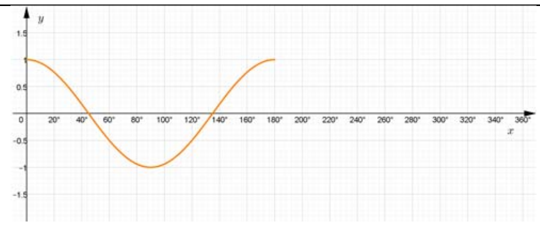
i.) Q5.1 - The period and the concept of domain are being confused. Even strong candidates gave the period as 180° instead of 360°.

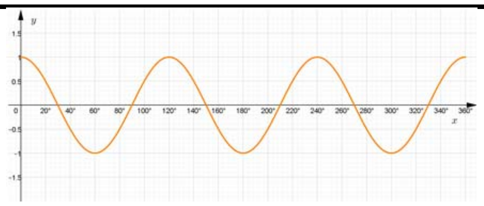
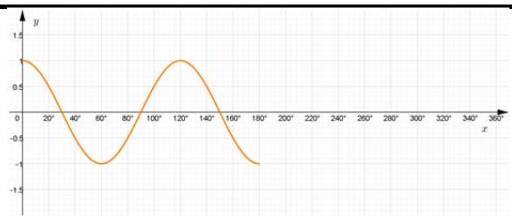
ii.) Q5.2 – Some candidates associated the *a* in $f(x) = a\sin x$ with the amplitude ONLY, and give thus a positive answer.

iii.) Q5.3 – Many candidates did not recognise that $x_T = 180° - 21,5° = 158,5°$

Suggestions for improvement

Learners must investigate the influence of k in y = cos kx as illustrate in the graphs below:

Function	Graph over [0°; 360°]	Graph over [0°; 180°]
y = cos x		
y = cos 2x		

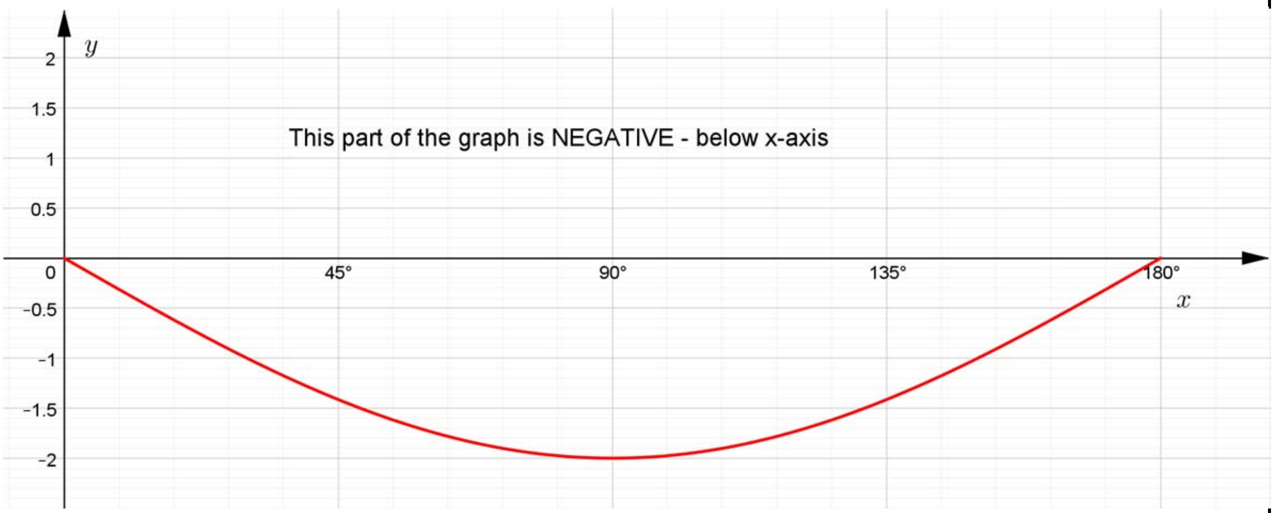
y = cos 3x		

Any restriction on the interval can be asked or given.

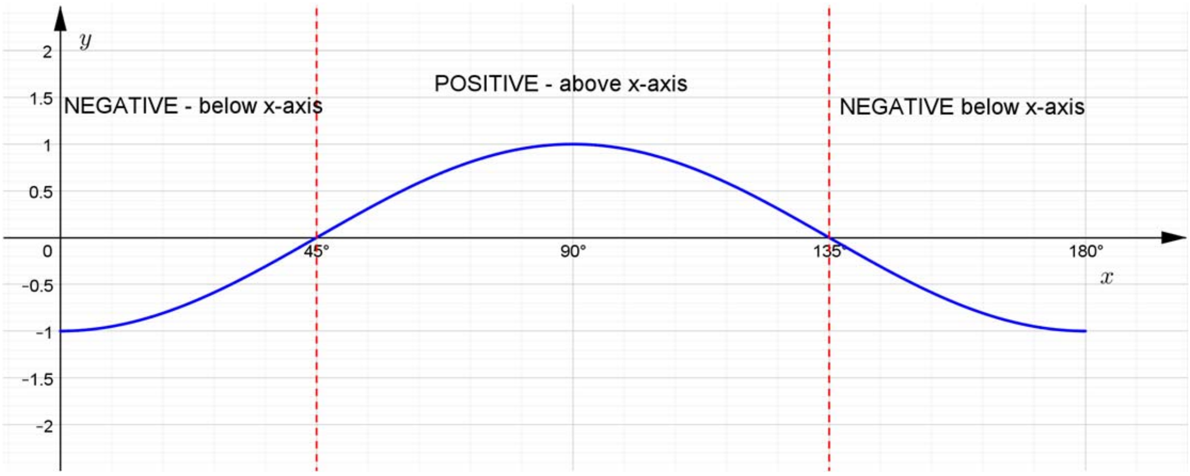
Question 5.4.1

Understanding the signs of the graphs, graphs drawn separately:

f(x) = -2sin x



g(x) = cos 2x:



Combining the graphs, we get the following situation as depicted in the graphs below:

From this, learners should be able to deduce that the required intervals are (0°; 45°) and (135°; 180°). Checking the required interval where this situation is true will give you the required answer of (135°; 180°)

Question 5.4.2

Here learners should have recognised that $\dfrac{f(x)}{g(x)}$ is undefined when g(x) = 0 and therefore at x=45° and x=135°. Teachers must expose learners to these types of questions.

The graphs that we are studying are the following according to the CAPS document:

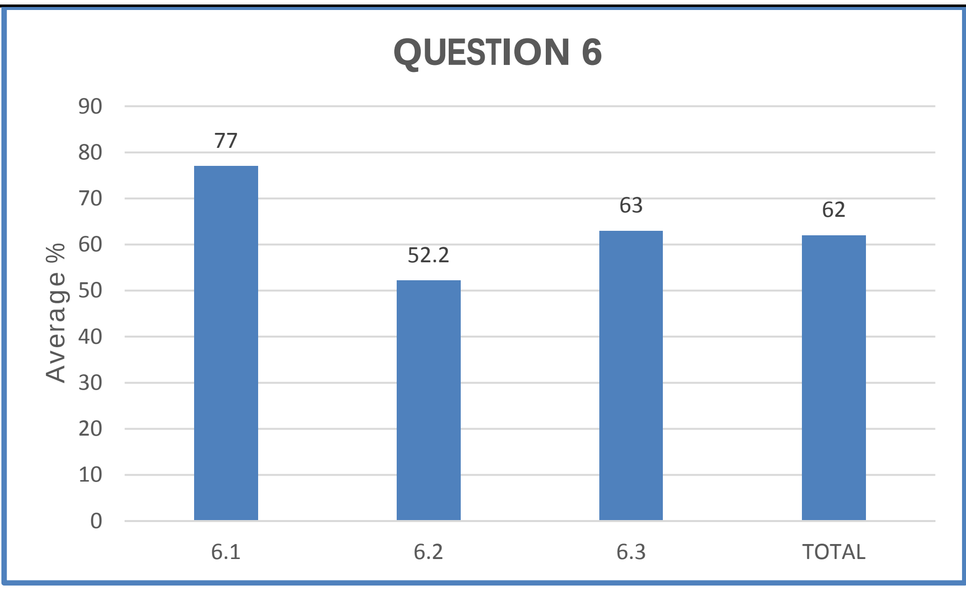
Function	**Impact on**
y = k sin x & y = k cos x	Amplitude and range
y = sin x + q & y = cos x + q	Range; start, end and turning points
y = k sin x + q & y = k cos x + q	Amplitude, range; start, end and turning points, etc.
y = sin (kx) & y = cos (kx)	Period, turning points, etc.
y = k tan x	Period = 180°; asymptotes at 90° & 270° Plotting (45°; k) and (135°; k)
y = sin (x + p) & y = cos (x + p)	Shifting of the graph to the left or right horizontally by p°.

Learners must be able to draw graphs as well determine the equation of the function from drawn graphs.

It's important for Technical learners to interpret information, reading off from graphs, tables, diagrams, etc. because it will be required in their future careers

QUESTION 6 [Total marks 12]

- This was a straight-forward question and only in 2D
- A well answered question by the sample candidates
- Q 6.1 – 74% scored full marks
- Q 6.2 – only 4% scored full marks
- Q 6.3 – 59% scored full marks
- Only 3% scored full marks for this question



Common errors and misconceptions

i.) Q 6.2 – Many candidates miss read the instruction that β is an obtuse angle

Suggestions for improvement

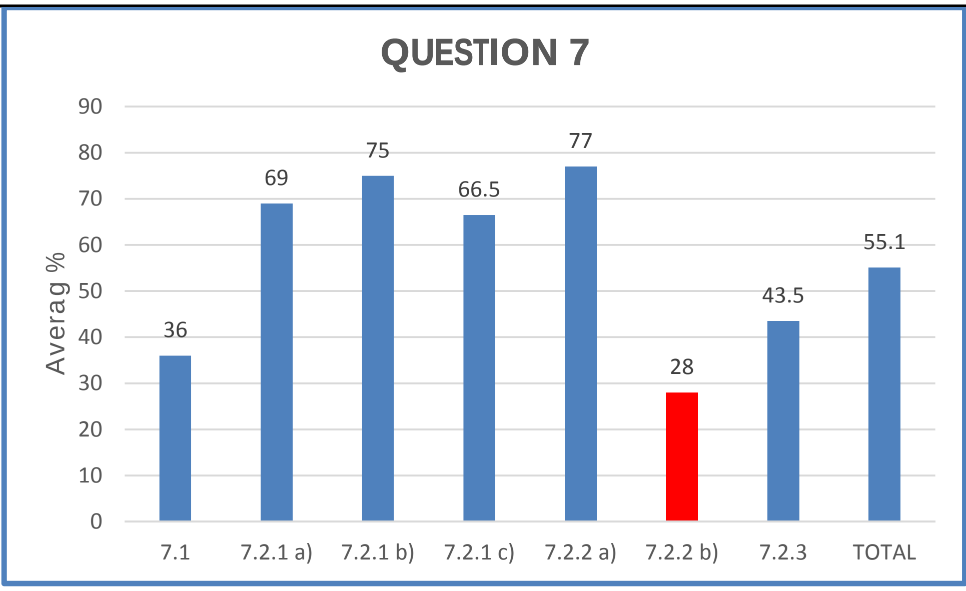
i.) In most cases or problems there will be a right-angled triangle for learners to apply any of the six trigonometric definitions

ii.) A common side will join the right-angled triangle with the non-right-angled triangle

iii.) The sine-, area- and cosine rule must be in terms of the required triangle not the general formula on the formula sheet

iv.) The use of the calculator is also here emphasised

QUESTION 7 [Total marks 12]
• 80% of sampled candidates passed this question with an average percentage of 55,2% with only 7% scoring full marks in this question • Q 7.1 – only 36% of sampled candidates scored full marks • Q 7.2.1 a) – 54% scored full marks • Q 7.2.1 b) – 75% scored full marks • Q 7.2.1 c) – 50% scored full marks • Q 7.2.2 a) – 77% scored full marks • Q 7.2.2 b) – worst answered sub-question; only 28% scored full marks • Q 7.2.3 – Only 26% scored full marks, with 48% achieving 50%+ for the sub-question

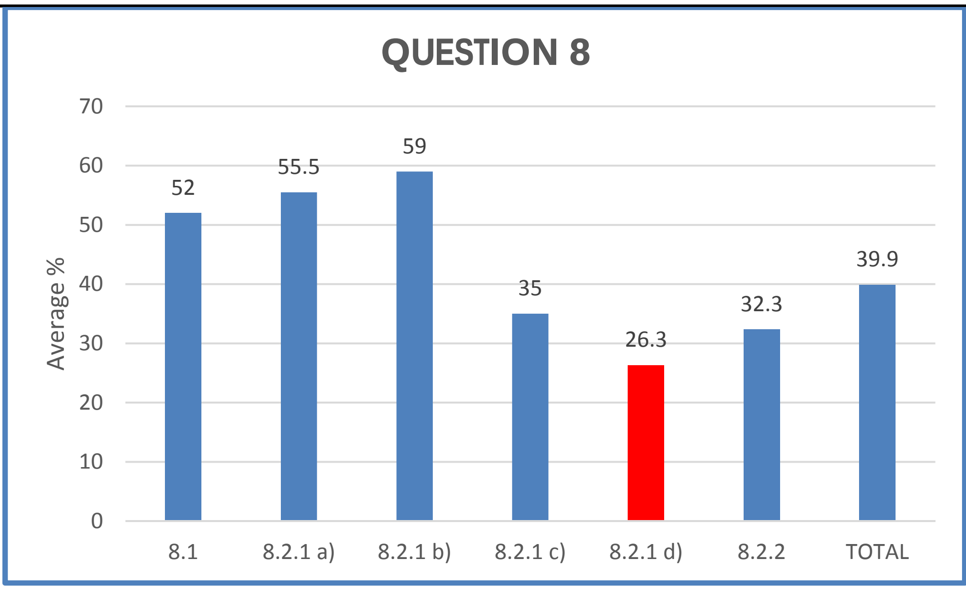


Common errors and misconceptions	
i.)	Q 7.1 – Too many candidates failed to complete the theorem statement
ii.)	Q 7.2.1 a) – many candidates did not recognise that the theorem ∠s *in the same segment* applies; one candidate gave an unnecessary explanation (for 2 marks!)
iii.)	Q 7.2.2 b) – many assumed AB bisected OD and therefore wrote ED = x; ED = 2x or ED = ½x was also popular options
iv.)	Q 7.2.3 – candidates were distracted by 7.2.2 b), not realising ΔAOE (3,4,5) and therefore x = 3; not seeing ΔAOE and using their incorrect value of ED simplified the solution and they were thus penalised. Candidates that used the segment-height-diameter formula erroneously substituted the required x for the x in the formula, which is the length of the chord.
v.)	Easy application of Pythagoras theorem or trigonometry ratios / height of segment formula were badly done.

Suggestions for improvement	
i.)	Practical investigation of all theorems is encouraged – EGD learners are in advantage position that must be explored
ii.)	It's only by exposing learners to enough riders that they will improve
iii.)	Euclidean Geometry reasons must be as Examination Guidelines
iv.)	For classwork – learners to practice completing the statement; Matching columns – theorem statement to be match of the abbreviate theorem statement

QUESTION 8 [Total marks 14]

- Only 3% of sampled candidates scored full marks for this question
- Average for the question was 39,9% with 76% of sampled candidates passing this question
- Q 8.1 – 52% of learners scored full marks
- Q 8.2.1 a) – 40% scored full marks
- Q 8.2.1 b) – 47% scored full marks
- Q 8.2.1 c) – 24% scored full marks
- Q 8.2.1 d) – 11% scored full marks
- Q 8.2.2 – 14% scored full marks with 48% passing the sub-question



Common errors and misconceptions

i.) Many candidates assumed that CD ∥ BE as well as BF ∥ DO and that CB = CD

ii.) Q 8.1 – Too many candidates failed to complete the theorem statement stating that the angle is 90° or a right angle

iii.) Q 8.2.1a) - 31% of candidates left out the reason with 29% that could answer the question

iv.) Q 8.2.1b) – Again 29% of candidates achieved zero for this question with 17% of them achieving in (a) & (b) zero

v.) Q 8.2.1c) – 54% achieved zero for this question – many did not see that $\hat{O}_1 = 2\hat{D}_2$ - angle at centre theorem and because they could not solve (b) they struggled with this question

vi.) Q 8.2 – many candidates assumed that $\hat{C}_1 = \hat{D}_1$ which resulted in unexpected results in their responses, in particular Q 8.2.2

Suggestions for improvement

i.) Learners must be taught to show information especially if it was not given; assuming information will be penalised

ii.) Learners should investigate theorems practically by construction and measurement before getting to the theoretical aspect. The discovery method would enable them to own the results and then formulating the general rule should be easy to recall.

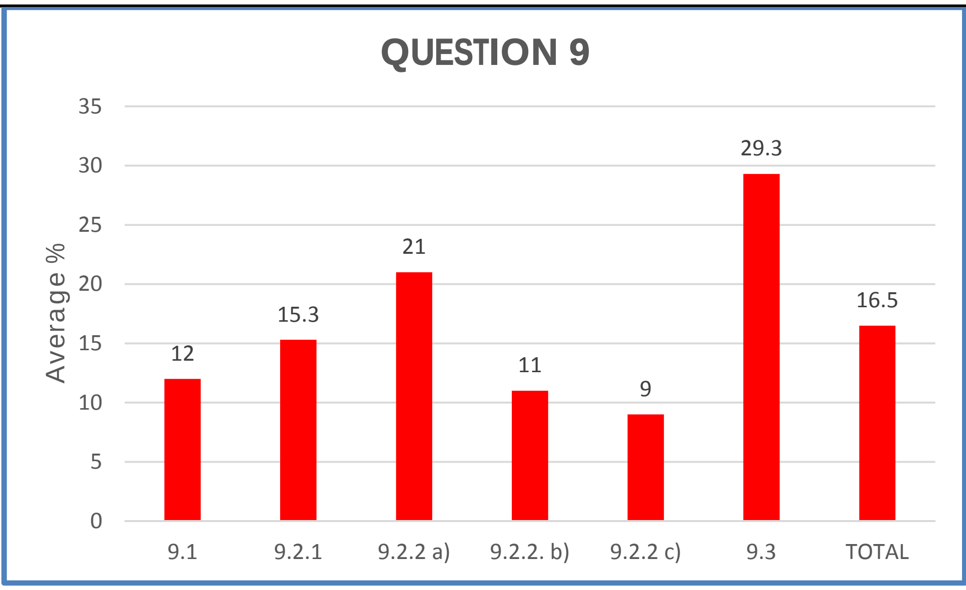
iii.) Setters of papers should indicate unequal angles with different arcs or indicate the size of the angles, so to minimise the unintended results.

iv.) More practice in solving riders must be done by learners.

v.)	If Euclidean Geometry reasons are not as per CAPS or Examination Guidelines, learners will forfeit the mark(s)

QUESTION 9 [Total marks 15]

- This was again the worst question answered in the paper
- None of the sampled candidates achieved full marks for this question
- Q 9.1 – 12% scored full marks
- Q 9.2.1 – 4% scored full marks
- Q 9.2.2 a) – 20% scored full marks
- Q 9.2.2 b) – 9% scored full marks
- Q 9.2.2 c) – 7% scored full marks
- Q 9.3 – 13% scored full marks



Common errors and misconceptions

i.) Q 9.1 – Incomplete or incorrect theorem statement, many only mentioned *Parallel* instead of *Parallel to the third side*.

ii.) Q 9.2.1 – candidates did not know how to prove lines parallel, a concept taught from grade 8 or they could not provide the appropriate reason(s)

iii.) Q 9.2.2 – candidates used wrong proportions and therefore scored minimal marks in this question

iv.) Q 9.2.2 b) – many candidates did not see that $\frac{EG}{OG}=\frac{2}{5}$

v.) Q 9.2.2 c) – Only 11% of sampled candidates managed to score marks; many had no idea how to attempt the question

vi.) Q 9.3 – Many candidates could not prove similarity; some attempted to prove congruency.

Suggestions for improvement

i.) Practical investigation, with guidance, is needed when the topic is introduced, so that learners can discover the results for themselves and thus internalise it.

ii.) Learners must not assume that the given ratio means the length of the sides; Teachers to clearly emphasise the difference.

iii.) Afterwards enough exercise must be done to reinforce what they have learnt.

iv.) An incorrect proportion, results in a breakdown and zero marks are therefore awarded.

v.) To prove lines parallel:

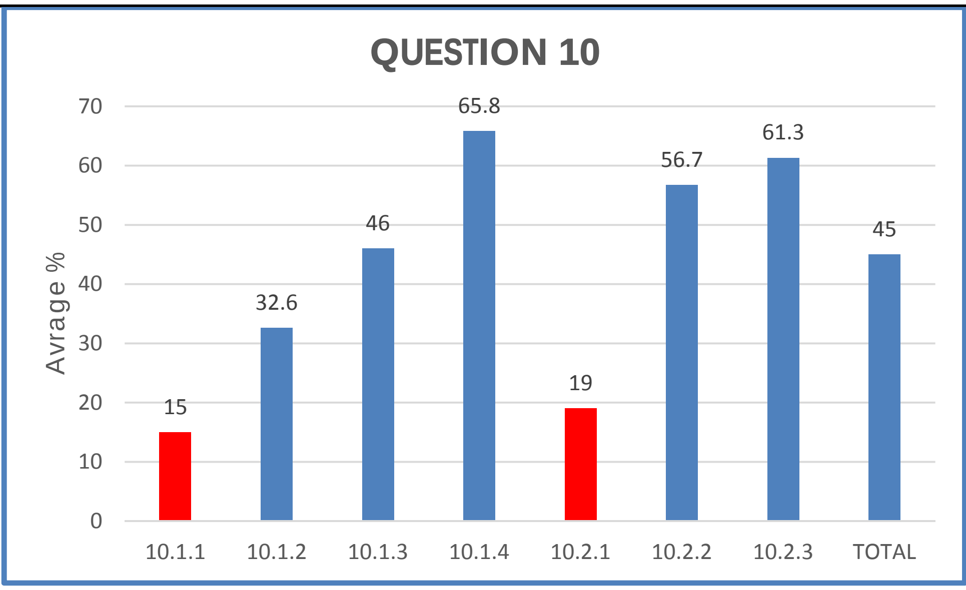
a. Either prove alternate- or corresponding angles are equal, or the co-interior angles are supplementary.

b. Using the Midpoint theorem

c. Using the theorem: *line* divides *two sides of a Δ in proportion*

vi.) To prove triangles similar, either prove (a) equiangular or (b) corresponding sides in proportion

QUESTION 10 [Total marks 22]
• No sample candidate scored full marks for this question • Q 10.1.1 – Only 15% scored full marks • Q 10.1.2 – Only 5% scored full marks • Q 10.1.3 - Only 5% scored full marks • Q 10.1.4 – Only 12% scored full marks • Q 10.2.1 – Only 10% scored full marks • Q 10.2.2 – 50% scored full marks • Q 10.2.3 - 51% scored full marks



Common errors and misconceptions

i.) Q 10.1.1 - Although the last statement of the given information, many candidates did not realise that OB (radius) of the hole = 1,5 to determine BC = OC – OB

ii.) Q 10.1.2 – 17% of the candidates calculate AC correctly, but forget to finalise the answer by calculating AB. 10% messed up with the substitution and the final answer

iii.) Q 10.1.3 – This was an unintended easy question, if candidates realised that for the given problem the angular velocity and the rotational frequency were the same. Very few candidates realise that n = 64π and could have scored full marks; Many calculated ω not realising it was given. Making *n* the subject of the formula was also challenging for some candidates, some simplifying $64\pi = \pi(40)n$ to $n = 64\pi - 40\pi$ erroneously

iv.) Candidates are still confused when to use π = 180° or when to use π ≈ 3,142

v.) Q10.2.1 – Only 10% achieved full marks for this question. Many candidates only scored a mark for converting to radians; some assumed the angle to be 90°. Many did not understand that AÔB is an angle to be calculated, they had 5,2 + 5,2 = 10,4 i.e. adding AO(radius) + OB(radius)

vi.) Q 10.2.3 – many wrote both formulas for the area, instead of selecting one

Suggestions for improvement

i.) When we work with angles, we use π = 180° and when we work with velocity, we use π ≈ 3,142, but we don't use the rounded value (use the calculator)

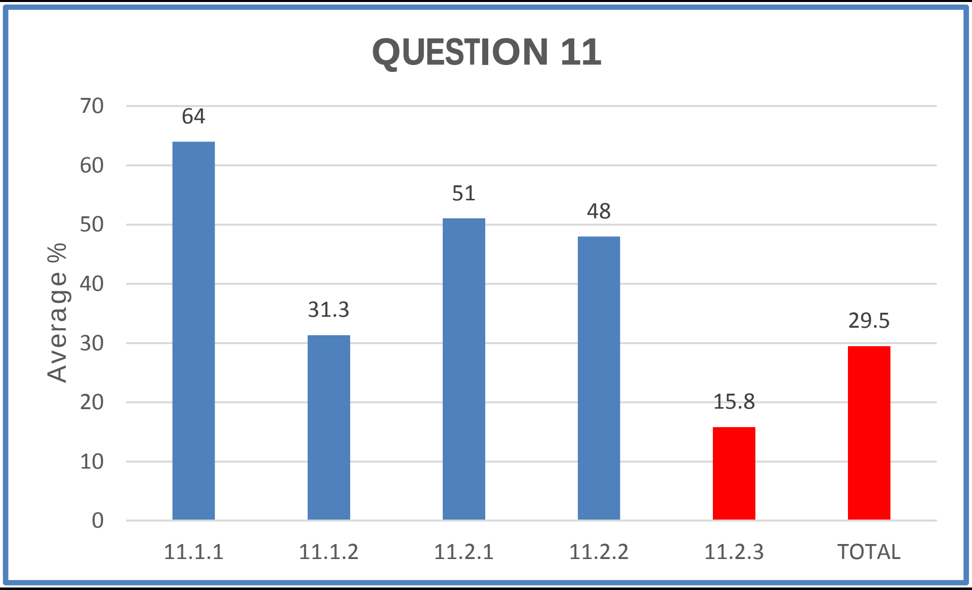
ii.) Learners must know the different units the variables are given and the table below should assist:

Concept	Symbol	Units	Short
Rotational frequency	N	Revolutions/time	Rpm or rps
Angular displacement	θ	Radians/degrees	
Angular velocity	ω	Radians/time	Rad/min or rad/sec
Circumferential / Peripheral velocity	υ	Distance unit/time	Distance unit $\in$ {km; m; cm; mm} Time $\in$ {hours; min; sec}

iii.) Changing the subject of the formula must be thoroughly practiced

QUESTION 11 [Total marks 14]

- Only 34% of sample candidates passed this question
- None score full marks for this question
- As expected Q 11.1.1 is the best performed sub-question with 11.2.3 the worst performing sub-question asking candidates to determine the total surface area of a rectangular prism and a half-cylinder.



Common errors and misconceptions

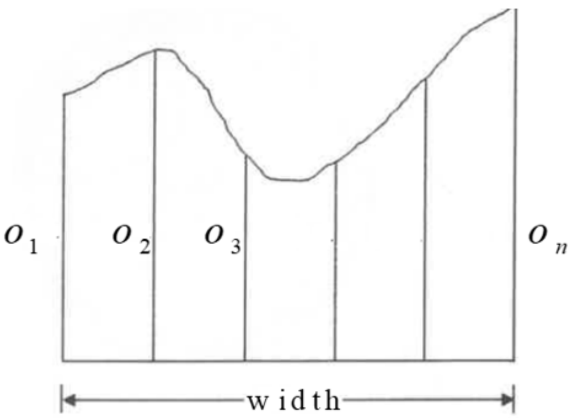
i.) Q 11.1.2 many candidates did not calculate $\frac{2}{3}$ of the area, as well as they did not divide the bottom side into 5 equal lengths. Many copied the formula incorrectly. Further, many candidates did not substitute the value of *b* into the formula. Algebraic simplification to determine the value of *q* was for many candidates a big challenge

ii.) Q 11.2.3 Many calculate the area of rectangle not the area of the total surface area, because the area of the rectangle was given not the total surface area of the rectangular prism. They did not calculate the half of the cylinder – they only use the full cylinder formula as given. Many substitute the height of the prism calculated in Q 11.2.1 into this height formula of the cylinder, maybe assuming they must be the same because it was given in the diagram as well as in the formula

Suggestions for improvement

Learners apply the formula incorrectly or they misunderstood.

1) Calculating the area of an irregular figure using the **ordinates**:



$$\text{Area} = a\left(\frac{1^{th} + last}{2} + 2^{nd} + 3^{rd} + \ldots + 2nd\ last\right)$$

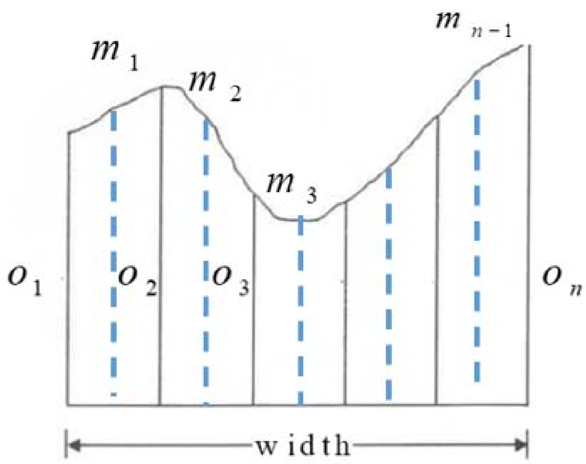
$$\text{Area} = a\left(\frac{o_1 + o_n}{2} + o_2 + o_3 + \ldots + o_{n-1}\right)$$

$$a = \frac{width}{\text{number of equal parts}}$$

$$n = \text{number of ordinates}$$

$$o_i = \text{an ordinate};\ i = 1; 2; \ldots; n$$

2) Calculating the area of an irregular figure using the **mid**-ordinates:



$$\text{Area} = a\,(m_1 + m_2 + m_3 + \ldots + m_{n-1})$$

$$a = \frac{width}{\text{number of equal parts}}$$

$$n = \text{number of ordinates}$$

$$m_i = \frac{m_i + m_{i+1}}{2}; \quad i = 1; 2; \ldots; n-1$$

Note the difference of the formula in comparison with CAPS document.

The number of mid-ordinates are one less than the ordinates, therefore the adjustment in the formula to m_{n-1}.

Teachers and learners to take note of this, the formula in the CAPS document or Examination Guidelines are still applicable until changed in 2021.

The formula looks difficult to read, but its Mathematically correct, especially using the index of *i*.

Teachers must give learners plenty of exercises to calculate the surface area and volumes of right prisms, cylinders, pyramids, cones and spheres.

Expose learners to different combinations of these geometric objects.

OVERALL COMMENT
• Markers of this paper are of the opinion that the paper was of a higher order with less level one questions asked. • These are practical learners and as such our teaching needs to be more of a practical nature • Proportionality was for the second year the worst performing question and maybe unfair to pitch a higher order question like Question 9.3 • Proportionality in Euclidean Geometry as well as the interpretation of Trigonometric graphs need more attention. • Some learners can figure out the Euclidean Geometry problem, but struggle to provide the correct reason as per Examination guideline. • Teachers must only use Examination guidelines reasons in their teaching. • All learners must have a calculator and teachers need to deliberately teach learners the use thereof. • SMTs must be more hands on when it comes to monitoring curriculum coverage and running intervention/support programmes • The type of learner is a big challenge – many strong learners opt for Mathematics • Some of the current cohort were progressed from Grade 9 in 2016 – worst case scenario some was given 20% and at a pure Technical school there is no soft option of Mathematical Literacy. These learners progress from grade to grade, because most of their other subjects have a practical component and they therefore pass relatively easily. • Further, some of the subjects offered at grade 8 and 9 levels does not support the development of a Technical learner at a PURE Technical school. • In the absent of a practical component, we need to advocate for an adjustment in the weightings of the SBA to Exam from 25:75 to 40:60 • Academic schools offering EGD are also encouraged to offer Technical Mathematics for their weaker Mathematics learner achieving between 30 and 50 percent, other learners must take Mathematical Literacy.