basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

QUALITATIVE ANALYSIS OF LEARNER RESPONSES AND EVALUATION OF QUESTION PAPERS: NSC 2018

SUBJECT	**MATHEMATICS**
PAPER	**ONE**
DURATION OF PAPER :	**3 HOURS**
PROVINCE	**KZN**
NAMES OF THE INTERNAL MODERATORS	**MS. T.B. MADONDO** **MRS. E. HOWARD**
NAME OF THE CHIEF MARKER	**MR. D. MAISTRY**
DATES OF MARKING	**1 – 14 DECEMBER 2018**
HEAD OF EXAMINATION:	**MR. R.C. PENNISTON**

QUALITATIVE ANALYSIS OF LEARNER RESPONSES

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

In November 2018 almost 75 000 candidates from KZN wrote the NSC examination in Mathematics. The number of candidates have decreased from 2017, by between 8000 and 9000.

At the marking centre one hundred Paper 1 scripts were randomly selected and the marks from those scripts were recorded.

The average mark for the candidates from this random sample of 100 candidates was 59 out of 150 (39%), compared to 44 out of 150 (29%) for 2017.

The table below shows the distribution of the total marks of the 100 learners:

No. of candidates	Total marks obtained in the question paper as a percentage									
	0 -9%	10 -19%	20 -29%	30 – 39%	40 – 49%	50 – 59 %	60 – 69%	70 – 79%	80 – 89%	90 – 100%
2017	23	23	7	12	17	10	2	5	1	0
2018	7	12	15	18	22	13	5	2	5	1

The table above clearly shows a clear improvement in performance from 2017 to 2018.

A similar analysis was done, both in 2016 and 2017, and the table below compares the findings of the three years:

Results obtained from a randomly selected sample of 100 KZN Mathematics Paper 1 scripts			
	November 2016	November 2017	November 2018
Pass percentage	44%	47%	66%
Average mark	29% (44 out of 150)	29% (44 out of 150)	39% (59 out of 150)

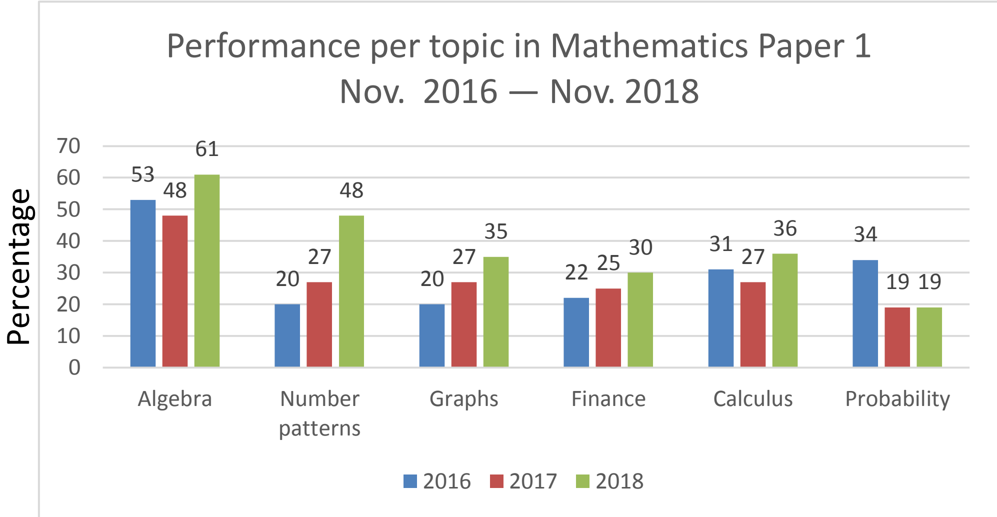
From the table it can be seen that both the average mark and the number of learners obtaining a passmark in the question paper is much higher in 2018 than it was in 2016 and 2017.

From the analysis of the marks of this sample of 100 candidates we can therefore predict a substantial improvement in the performance in Paper 1 Mathematics in KZN for 2018.

SECTION 2: Comment on candidates' performance in individual questions

PERFORMANCE PER TOPIC:

The graph below was compiled using the sample of 100 scripts:



In all topics, except for Probability, the performance has improved.

The poor performance in Probability indicates that this section is still not taught as effectively as sections that have been part of the curriculum for a longer time. Teachers have to strive to improve their teaching of this topic.

QUESTION 1
EQUATIONS, INEQUALITIES and ALGEBRAIC MANIPULATION

	1.1.1	1.1.2	1.1.3	1.1.4	1.2	1.3	**Total**
Maximum mark	3	3	3	4	6	4	**23**
Average mark	2,8	2,5	1,3	2,4	4,6	0,4	**14,0**
Average %	92%	85%	43%	60%	77%	10%	**61%**

Candidates performed well in question 1, with an average mark of 61% compared to 39% for the question paper as a whole.

QUESTION 1.1.1:

Skill tested:
Solving a quadratic equation using factorisation.

Observations regarding responses:
- Almost all candidates could answer this question correctly.
- Instead of factorising, many candidates used the formula for the roots of a quadratic equation.
- Some candidates left out the "$= 0$", thereby changing the equation into an expression.
- Some candidates made a mistake with the signs in the process of factorisation, i.e. wrote $(x+1)(x+3)=0$, instead of $(x-1)(x-3)=0$.
- Some candidates made a mistake when transposing a term, and e.g. wrote down $x-1=0$, $\therefore x=-1$.

QUESTION 1.1.2:

Skill tested:
Solving a quadratic equation using the formula.

Observations regarding responses:
- Very well answered.
- Too many candidates could not round off correctly to two decimal places, and therefore lost one mark.
- Some candidates wrote $\frac{-5\pm\sqrt{5^2-4(5)(1)}}{2(5)}$, instead of $\frac{5\pm\sqrt{5^2-4(5)(1)}}{2(5)}$, i.e. they couldn't substitute the $b=-5$ correctly.

QUESTION 1.1.3:

Skill tested:
Solving a quadratic inequality.

Observations regarding responses:
- This is a standard type of question that is asked in almost every Gr. 12 Mathematics Paper 1, but the performance of candidates in this question is much weaker than would be expected.
- Most of the candidates could factorise the expression, but could not write the correct answer.
- Many candidates have the misconception that:
  because $a.b=0$ implies that $a=0$ or $b=0$,
  $a.b>0$ will in a similar way imply that $a>0$ or $b>0$.
  This means that they treat an inequality in exactly the same way as an equation.
- Some candidates drew a parabola and indicated the correct solution on the sketch, but were not able to **write down** the correct solution from the sketch.

QUESTION 1.1.4:	Observations regarding responses:

QUESTION 1.1.4:
 	
Skill tested:
Solving a surd equation.
	Observations regarding responses:
	• Fairly well answered.
	• Some candidates incorrectly "transposed" the 3, i.e. changed $3\sqrt{x}=x-4$, to $\sqrt{x}=x-7$.
	• Some candidates divided both sides by 3, before squaring. This is not incorrect, but dealing with the fractions so created, made the question more complicated and the likelihood of making mistakes much greater.
	• Almost all candidates realised that they had to square both sides of the equation in order to remove the surd. However, many mistakes were made in the process, e.g.:
	  o $3x=x^2-8x+16$ (not squaring the coefficient of $\sqrt{x}$)
	  o $9x=x^2+16$ (leaving out the middle term when squaring the binomial)
	• 40 out of 100 candidates obtained the two correct x-values, but only 18 of them checked the validity of the two answers and rejected the invalid one.

QUESTION 1.2: ***Skill tested:*** Solving two simultaneous equations, one linear and one quadratic.	***Observations regarding responses:*** • Well answered. • Some candidates wrote $-y=2-3x$, and then substituted $2-3x$ for y. • Some candidates chose to make x the subject of the formula, i.e. $x=\frac{y+2}{3}$. In this way they made the question more difficult and very few of them could calculate the correct x and y values using this method.
QUESTION 1.3: ***Skill tested:*** Simplifying an expression involving exponents and surds.	***Observations regarding responses:*** • This was a higher order question and revealed the fact that candidates lack conceptual understanding of the laws of exponents. • Candidates seemed not to know where to start working on this problem, how to utilise the given information, namely that $3^{9x}=64$ and $5^{\sqrt{p}}=64$, in order to simplify $\frac{\left[3^{x-1}\right]^3}{\sqrt{5}^{\sqrt{p}}}$.

Suggestions for improvement in teaching and learning:

✓ More thorough teaching of factorisation in grades 9 and 10 is needed. A grade 12 learner shouldn't make mistakes when factorising. A good strategy is to teach learners to always multiply out again after they factorised, just to make sure that they get back the expression that they have started with.

✓ To lose a mark for incorrect rounding off should simply not happen. Teachers should check whether learners know exactly how to do it, and if they are not sure, let them practice enough until they are confident to do it correctly.

✓ To ensure that learners get enough practice in gr. 11 on finding the roots of a quadratic equation using the formula – including examples with positive and negative values for a, b and c, and values different than 1 for a.

✓ To take some time, preferably in gr. 10, to focus on teaching learners how to represent inequalities (e.g. $-2<x\leq 5$; $x<-2$ or $x>5$) on a number line; and also the opposite: how to write an inequality from the illustration on a number line. This skill is needed regularly and ensuring that learners have mastered it, will be very beneficial to them.

✓ To show learners how to check the validity of the roots of a surd equation, and to keep on reminding them to do that, as often as is necessary.

✓ Exponents should be taught with the aim of learners really understanding the laws and not just memorising them.

QUESTION 2

NUMBER PATTERNS: A QUADRATIC NUMBER PATTERN and AN ARITHMETIC SEQUENCE

	2.1.1	2.1.2	2.1.3	2.2	2.3	**Total**
Maximum mark	1	4	2	3	6	**16**
Average mark	0,9	3,2	1,5	2,1	1,3	**9,0**
Average %	90%	80%	77%	69%	22%	**56%**

Very well answered, except for question 2.3.

QUESTION 2.1.1:

Skill tested:
Determining the next term of a quadratic number pattern.

Observations regarding responses:
- Very well answered.
- Some candidates gave 36 as answer, instead of 42. They treated the number pattern as linear, although it was stated in the question that it is a quadratic number pattern.

QUESTION 2.1.2:

Skill tested:
Determining the general term of a quadratic number pattern.

Observations regarding responses:
- Very well answered.
- Some candidates used $2a+b=1$, instead of $3a+b=1$, to calculate the value of b.

QUESTION 2.1.3:

Skill tested:
Calculating the value of a specific term of a quadratic sequence.

Observations regarding responses:
- Well answered.
- Some candidates took 20 to be the value of T_n instead of the value of n.

QUESTION 2.2:

Skill tested:
Calculating the position of a specific term in an arithmetic sequence.

Observations regarding responses:
- Well answered.
- Common mistakes were to:
  - equate n instead of T_n to -140.
  - equate T_n to zero instead of to -140.
  - express T_n as $35+(n-1)-7$, instead of $35+(n-1)(-7)$.
  - forget to change the sign when transposing a term.

QUESTION 2.3:

Skill tested:
Calculating the value of n if the sum of n terms of a certain arithmetic sequence is equal to the n^{th} term of a specific certain number pattern.

Observations regarding responses:
- Poorly answered.
- Some candidates worked with T_n of the arithmetic sequence instead of S_n
- Some candidates did not realise that they had to reject the value of $\frac{2}{13}$ for n.

Suggestions for improvement in teaching and learning:

✓ When working with a quadratic number pattern it is good practice to clearly write down the terms, the first differences and the second differences, using what is called by some teachers the "pineapple method":

terms:	2		3		10		23		**42**
1st differences:		1		7		13		**19**	
2nd differences:			6		6		**6**		

✓ When teaching this section it is important to emphasise the difference between the position (n) and the value of a term (T_n) in a sequence. It takes most learners a while to get clarity on this; expect them to make mistakes and use those mistakes to again point out the difference between n and T_n, until it is clear to all the learners.

✓ To teach learners that when reading a number pattern question, they have to first identify the type of sequence (arithmetic, geometric or quadratic) they will be working with and the formula (general term for AS, GS or quadratic sequence; or sum of AS or GS or sum to infinity of GS) that will be applicable.

QUESTION 3
NUMBER PATTERNS: A GEOMETRIC SERIES and SIGMA NOTATION.

	3.1	3.2	3.3	3.4	**Total**
Maximum mark	2	2	4	3	**11**
Average mark	1,3	1,3	1,0	0,3	**3,9**
Average %	64%	64%	25%	10%	**35%**

Questions 3.1 and 3.2 has been answered fairly well, but 3.3 and 3.4 not well at all.

QUESTION 3.1: ***Skill tested:*** Calculating the first term of a geometric sequence, given the value of the constant ratio and the sum to infinity.	***Observations regarding responses:*** • Well answered. • Instead of the formula for the sum to infinity of a geometric series, some candidates used the formula for T_n or S_n. • Mistakes were made in simplification after substitution, resulting in answers like $a=12$ or $a=-3$ instead of $a=6$.
QUESTION 3.2: ***Skill tested:*** Calculating the value of a specific term of a quadratic sequence.	***Observations regarding responses:*** • Fairly well answered. • Some candidates again used an inappropriate formula, namely that for S_n instead of T_n.
QUESTION 3.3: ***Skill tested:*** Calculating the number of terms in a geometric series if the sum of the series is given.	***Observations regarding responses:*** • Not well answered at all. It was not a difficult question; however, interpretation of sigma notation seemed to be a challenge for many candidates • Many candidates used $r=2$ instead of $r=\frac{1}{2}$. • Some candidates displayed a lack of insight in working with exponential expressions by simplifying in the following way: $3\left[1-\left(\frac{1}{2}\right)^n\right]=3\left[\frac{1}{2}\right]^n=\left(\frac{3}{2}\right)^n$
QUESTION 3.4: ***Skill tested:*** Comparing two geometric series, both expressed using sigma notation.	***Observations regarding responses:*** • Poorly answered. Out of 100 candidates 82 obtained no marks in this question. Only 5 learners could obtain 3 out of 3 marks. • Most of the candidates who did attempt this question just worked with T_n, instead of expanding each of the sigma notations into a series. Once you have the terms of the series it is much easier to get the values of a and r, and to even find a way to get to the answer.

Suggestions for improvement in teaching and learning:

✓ In the teaching of sequences and series more attention need to be given to sigma notation. The best strategy is to always expand the sigma notation, i.e. to write down the terms of the series.

QUESTION 4
FUNCTIONS AND GRAPHS: A PARABOLA and ITS INVERSE

	4.1	4.2	4.3	4.4	**Total**
Maximum mark	2	1	2	3	**8**
Average mark	0,9	0,6	1,2	0,7	**3,4**
Average %	45%	60%	60%	22%	**43%**

QUESTION 4.1: ***Skill tested:*** To know the definition of a function.	***Observations regarding responses:*** • Not well answered. In a question directly testing content knowledge like this, all candidates should be able to get full marks.
QUESTION 4.2: ***Skill tested:*** Reflecting a point in the line $y = x$.	***Observations regarding responses:*** • Fairly well answered.
QUESTION 4.3: ***Skill tested:*** Calculating the value of a variable by using the given equation of a parabola and the coordinates of a point on the parabola.	***Observations regarding responses:*** • Fairly well answered. • Some candidates substituted the coordinates of R, and not P, but R is a point on f^{-1} and a is a variable in the equation of f and not f^{-1}. They therefore substituted $x = -12$ and $y = -6$, instead of vice versa. • Some candidates wrote $(-6)^2 = -36$.
QUESTION 4.4: ***Skill tested:*** Determining the equation of the inverse of a parabola.	***Observations regarding responses:*** • Poorly answered. • Many candidates gave an answer including logs, i.e. they confused the inverse of the parabola with that of othe exponential function. • In some cases there was poor algebraic manipulation when making y the subject of the formula. From $x = -\frac{1}{3}y^2$, candidates wrote down e.g. $y^2 = -\frac{1}{3}x$ or $y^2 = 3x$ (instead of $y^2 = -3x$). • Some candidates gave the answer as $y = \pm\sqrt{-3x}$, instead of $y = \pm\sqrt{-3x}$. • Most candidates omitted the restriction on the domain of the inverse function. The complete answer is: $y = -\sqrt{-3x},\ x \le 0$.

Suggestions for improvement in teaching and learning:

✓ There are three functions for which learners need to be able to find inverses: the straight line, the parabola and the exponential function. Teachers should teach all three types, and not just focus on one of them. Learners has to know how to get the inverse of each and what the differences are between them.

✓ Transformation should be taught in an investigative way.

QUESTION 5
FUNCTIONS AND GRAPHS: A HYPERBOLA

	5.1	5.2	5.3	5.4	**Total**
Maximum mark	1	2	3	2	**8**
Average mark	0,4	1,0	1,6	0,2	**3,2**
Average %	40%	50%	53%	10%	**40%**

QUESTION 5.1: ***Skill tested:*** To determine the domain of a hyperbola, given its equation.	***Observations regarding responses:*** • An easy question, but not well-answered. • Some candidates don't know the difference between domain and range and gave an answer with the values of y. • Many candidates only stated that $x \in R$, without excluding $x = 1$.
QUESTION 5.2: ***Skill tested:*** To write down the equations of the asymptotes of a hyperbola, given the equation of the hyperbola.	***Observations regarding responses:*** • An easy question, but not well answered. • Many candidates wrote $p = -1$ and $q = 0$. This is incorrect: the asymptotes are lines and their equations should include the variables x and/or y. • If the value of q is 0, candidates find it difficult to see that the horizontal asymptote is the x-axis.
QUESTION 5.3: ***Skill tested:*** To sketch the graph of a hyperbola.	***Observations regarding responses:*** • Not well answered. • Some candidates drew graphs plotting points determined using a calculator, not being aware of what the shape of a hyperbola should be and came up with graphs with a completely incorrect shape. • Many candidates drew only one "arm" of the hyperbola. • Some candidates drew graphs touching or intersecting the asymptotes. • Some candidates do not label the intercepts with the axes and the asymptotes.
QUESTION 5.4: ***Skill tested:*** To solve an inequality using the graph of a hyperbola.	***Observations regarding responses:*** • Poorly answered. This was a higher order question for which only 2 of the 100 candidates obtained full marks. • The expectation was to use the graph to solve the inequality. Some candidates attempted solving it algebraically, but failed.

Suggestions for improvement in teaching and learning:

✓ Teachers should spend time explaining, with the aid of appropriate examples, to learners what is meant by the domain and the range of a function. To teach learners how to determine the domain and range of a certain function, either from its equation or its graph.

✓ Learners should be taught to identify the asymptotes of a certain function from the values of p and q in the equations of the functions, and to write the equations of the asymptotes.

✓ Teachers should teach learners to read off solutions to inequalities from graphs.

✓ Learners should be taught to sketch graphs using transformations from the "mother graph", rather than by using a calculator to generate points for plotting.

QUESTION 6
FUNCTIONS AND GRAPHS: A STRAIGHT LINE and A PARABOLA

	6.1	6.2	6.3	6.4.1	6.4.2	6.5	6.6	**Total**
Maximum mark	2	3	3	4	2	5	1	**20**
Average mark	1,0	2,1	0,7	0,7	0,6	0,9	0,1	**6,1**
Average %	50%	70%	25%	18%	30%	18%	10%	**31%**

This question was not answered well.

QUESTION 6.1: ***Skill tested:*** Determining the equation of a straight line graph.	***Observations regarding responses:*** • Not well-answered. • This was a "show that" question. o Many candidates (incorrectly) started by writing down the given equation $g(x)=x+1$. They then concluded from the equation that $m=1$ and $c=1$; o They should instead have **used the graph** to calculate the values of m and c; and **then showed**, using $y=mx+c$ that $g(x)=x+1$.
QUESTION 6.2: ***Skill tested:*** Calculating the coordinates of the *x*-intercepts of a parabola.	***Observations regarding responses:*** • Well answered. • Some candidates lost a mark because of omitting the "= 0" after they have factorised. • Some candidates factorised incorrectly.
QUESTION 6.3: ***Skill tested:*** Determining the range of a parabola, given its equation.	***Observations regarding responses:*** • Poorly answered. • Many candidates determined the y-intercept $(0;-3)$ instead of the *y*-coordinate of the turning point, which was -4. They then gave the range as $y\geq-3$, instead of $y\geq-4$.
QUESTION 6.4.1: ***Skill tested:*** To determine for which *x*-value the parabola will be 6 units above the straight line.	***Observations regarding responses:*** • Fairly well answered. • Some candidates made the **assumption** that M is the reflection of C in the axis of symmetry of the parabola. They then used this to calculate the *x*-value at M and T. This is not a valid way of answering the question. • Some candidates **assumed** that AT = OA (= 1), and in this way calculated that the *x*-coordinate at T was -2. This is also not a valid method of answering the question. • Many candidates concluded that OT = -2. However, the length of a line segment cannot have a negative value.
QUESTION 6.4.2: ***Skill tested:*** To determine the coordinates of a point on a graph, by substituting into its equation.	***Observations regarding responses:*** • Not well answered.
QUESTION 6.5: ***Skill tested:*** To determine the equation of a tangent to a parabola.	***Observations regarding responses:*** • Very poorly answered. • Many candidates determined the derivative of f, because they realised that a derivative would be needed in this calculation of the equation of a tangent. Some of them then equated the derivative to zero, instead of 1, as they should have, since the gradient of the secant is equal to 1.

<table>
<tr><td>QUESTION 6.6:

Skill tested:
To determine the value of a variable k, for which the parabola and the straight line will not intersect.</td><td>Observations regarding responses:
• Very poorly answered.
• Most candidates apparently did not understand what the question actually meant and especially did not realise its connection to question 6.5.</td></tr>
<tr><td colspan="2">Suggestions for improvement in teaching and learning:

✓ When teaching functions ensure that all the available time is not spent on the drawing of the different types of graphs, but also on graph interpretation. To discuss aspects like
o calculating distances between two graphs;
o points of intersection;
o whether two graphs will intersect, or not;
o equations of tangents;
o the relationship between the roots of equations and graphs;
o etc.</td></tr>
</table>

QUESTION 7
FINANCE: A FUTURE VALUE ANNUITY and A HOME LOAN

	7.1.1	7.1.2	7.2.1	7.2.2	**Total**
Maximum mark	3	3	4	5	**15**
Average mark	0,6	0,3	2,3	1,4	**4,6**
Average %	20%	10%	57%	28%	**31%**

QUESTION 7.1.1: ***Skill tested:*** To calculate how much a future value annuity will be worth after 4 years.	***Observations regarding responses:*** • A straight-forward question to which the responses were rather disappointing. • Some candidates used the compound interest formula $A = P(1+i)^n$, instead of the future value annuity formula $F = \frac{x[(1+i)^n - 1]}{i}$. Too much teaching using past papers could have influenced candidates to expect a compound increase question before a future value question. • Candidates failed in calculating the appropriate values of i and n.
QUESTION 7.1.2: ***Skill tested:*** To recalculate how much the future value annuity will be worth after 4 years, given that a certain amount of money was withdrawn after 3 years.	***Observations regarding responses:*** • A much more difficult question than the previous one and candidates performed very poorly. • Many candidates subtracted R100 000 from the future value amount calculated in 7.1.1, but did not realise that they had to include interest on the R100 000 that was withdrawn. They wrote $R283972,28 - R100000$, instead of $R283972,28 - R100000\left(1+\frac{0,088}{4}\right)^4$.
QUESTION 7.2.1: ***Skill tested:*** Calculating the monthly instalment on a home loan.	***Observations regarding responses:*** • Generally well answered. • Some candidates substituted R1 500 000 for x, and then attempted to calculate the value of P. In other words, they confused the meanings of P and x. • Some candidates substituted the value of n as 20 instead of 240; and i as $0{,}105$ instead of $\frac{0{,}105}{12}$.

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<tr>
<td>QUESTION 7.2.2:

Skill tested:
Calculating the outstanding balance on the home loan, after 144 payments have been made.</td>
<td>Observations regarding responses:
• Not well answered. It is a more difficult question, but a standard type of question in the context of Financial Maths; and candidates should expect questions of this type.
• There are two main methods to calculate the outstanding balance on a loan:
o Calculating the present value of the remaining instalments: in this case the value of 240 –144 = 96 should be used for n; or
o Calculating $\mathrm{A} - \mathrm{F}$ = (loan amount + interest on it) – (future value of the instalments already made). In this case the value of n that should be used is 144.
Candidates often used 144 in the first method, or 96 in the second method, thereby demonstrating that they didn't really understand how the method works.</td>
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<tr>
<td colspan="2">Suggestions for improvement in teaching and learning:
✓ For teachers to use timelines when explaining how to work out problems in Financial Maths, and to encourage learners to do the same. This can help learners to understand questions better, especially questions like 7.1.2 and 7.2.2.
✓ To teach learners how to identify the appropriate formula in Financial Maths by making it very clear to them what each of the formulas (compound interest formula, future value annuity formula and present value formula) is used for and what the exact meaning is of each of the variables in these formulas.</td>
</tr>
</table>

QUESTION 8
CALCULUS: DETERMINING DERIVATIVES USING FIRST PRINCIPLES and RULES

	8.1	8.2.1	8.2.2	**Total**
Maximum mark	5	3	4	**12**
Average mark	4,0	2,3	1,0	**7,3**
Average %	80%	77%	25%	**61%**

This question has been answered well by most candidates.

QUESTION 8.1:

Skill tested:
Determining a derivative using first principles.

Observations regarding responses:

- Very well answered.
- Many candidates still make errors in notation, e.g. to write:
  - $f(x)=\lim\limits_{h\to 0}\dfrac{f(x+h)-f(x)}{h}$ (instead of $f'(x)$) or
  - $\lim\limits_{h\to 0} = \dfrac{f(x+h)-f(x)}{h}$ (= sign in incorrect place).
  - $\lim\limits_{h\to 0}(2x+h)=\lim\limits_{h\to 0}(2x)$ (instead of just having $2x$ as the answer).

  These notational errors indicates a lack of conceptual understanding.
- Some candidates left out the 5 when determining $f(x+h)$.
- Some candidates left out the brackets when determining $f(x+h)-f(x)$, causing errors in substitution and simplification.

QUESTION 8.2.1:

Skill tested:
Determining a derivative using rules.

Observations regarding responses:

- Very well answered. 62 out of 100 candidates obtained full marks in this question.
- Quite a number of candidates gave the derivative of $3x^3$ as $6x^2$, instead of $9x^2$.
- Many candidates also could not determine the derivative of x to be 1. They just left it out in their answers.

QUESTION 8.2.2:

Skill tested:
To make y the subject of the formula using factorisation, and then determine its derivative using rules.

Observations regarding responses:

- Poorly answered.
- Many candidates did not factorise, but just found the "derivative" of the terms on the RHS of the equation, namely $2x^2-2x$.
- Those candidates didn't realise that they had to factorise by taking out the common factor in both sides of the given equation.

Suggestions for improvement in teaching and learning:

✓ To explain to learners the meaning of the notation $\dfrac{dy}{dx}$, namely that it is an instruction to determine the derivative of y with regard to the variable x. Therefore, to answer a question like 8.2.2, it is necessary to first write y in terms of x, i.e. to first make y the subject of the formula before applying differentiation rules.

✓ To explain to learners that if we write $\lim 2x+h$, it means the limit only of the $2x$ and not of the h as well. If we want to indicate the limit of the whole expression, e.g. in the process of determining the derivative from first principles, we have to use brackets and write: $\lim(2x+h)$.

QUESTION 9

CALCULUS: GRAPHS OF CUBIC FUNCTIONS

	9.1.1	9.1.2	9.1.3	9.2	**Total**
Maximum mark	4	5	3	3	**15**
Average mark	0,4	2,2	1,0	0,4	**4,0**
Average %	10%	44%	33%	13%	**27%**

This question was not well answered.

QUESTION 9.1.1:

Skill tested:
To determine the equation of a cubic graph, given its y-intercept, one *x*-intercept and the fact that it has a turning point on the x-axis.

Observations regarding responses:
- Very few candidates could answer this question correctly.
- Many candidates set up two equations, using the given *y*-intercept and *x*-intercept. This however, did not provide enough information to calculate the unknowns and they couldn't go any further.
- Candidates seems to lack practice in problem solving strategies, i.e. to take note of all the information that have been given, so as to use that in determining the solution. In this case many candidates missed the implication of the turning point on the x-axis, namely that $g(x)$ will have a "repeated root".

QUESTION 9.1.2:

Skill tested:
Determining the coordinates of the turning points of a cubic graph.

Observations regarding responses:
- Not well answered, seeing that the equation was now known and it was given that P and R are turning points of g. Determining the coordinates of the turning points of a cubic function is a basic skill that all candidates should be able to do correctly.
- Some candidates did not equate the derivate to zero; they just assumed that and lost one mark as a result.
- Few candidates could solve $3x^2+2x-16=0$ by means of factorisation.
- Some candidates made mistakes in the calculation of $g\left(-\frac{8}{3}\right)$.

QUESTION 9.1.3:

Skill tested:
To determine whether the graph will be concave up or down at a certain point on the graph.

Observations regarding responses:
- Not well answered.
- Many candidates calculated the second derivative, equated it to zero and even found the *x*-value of the point of inflection, but could not draw the correct conclusion about concavity. This indicates a lack of understanding of this concept.

QUESTION 9.2:

Skill tested:
Drawing a sketch graph of a cubic function, not given its equation, but just some information about its intercepts with the axes and first and second derivatives.

Observations regarding responses:
- Very poorly answered.
- Many candidates drew graphs of cubic functions with two turning points, instead of just one. One reason for this could be that this type of graph has not been asked for quite a few years.
- Candidates could not interpret the given information correctly, especially $g''(x)>0$ when $x<3$, and $g''(x)<0$ when $x>3$.

Suggestions for improvement in teaching and learning:

- ✓ When teaching graphs of cubic functions to also include those that have only one stationary point.
- ✓ To teach the concept of concavity more thoroughly, not just as rules, e.g. that .a graph is concave up if $f''(x)>0$, that concavity changes where $f''(x)=0$, etc. But that learners will know what it looks like where a graph is concave up.

QUESTION 10
CALCULUS: THE MAXIMUM AREA OF A PARALLELOGRAM

	10.1	10.2	**Total**
Maximum mark	1	5	**6**
Average mark	0,3	0,2	**0,5**
Average %	30%	4%	**9%**

QUESTION 10.1:

Skill tested:
To use the proportional intercept theorem to write down the ratio of the lengths of two line segments in a triangle.

Observations regarding responses:
- Not very well answered.
- Many candidates did not attempt this question.
- Some candidates gave the answer as 2 : 3, instead of 3 : 2.

QUESTION 10.2:

Skill tested:
To apply optimisation in calculus to calculate the value of a variable when the area of a parallelogram reaches a maximum.

Observations regarding responses:
- Only ….. out of 100 candidates .could answer this question correctly. Most candidates did not even attempt to answer it.
- This question required integration of Calculus and Euclidean Geometry. This is a higher order skill.
- Most candidates were not able to determine the base and the height of the parallelogram in terms of t.
- Some candidates took the base of the parallelogram to be
  - BC $(5-t)$ instead of FC ($\frac{3}{5}(5-t)$); and
  - the height to be AG (t) instead of HG ($\frac{2}{5}t$).
- Some candidates calculated the area of triangle ABC, instead of the area of parallelogram DECF.

Suggestions for improvement in teaching and learning:

✓ Optimisation will always be tested in a certain context. It could involve volumes and surface areas of objects, or perimeter of figures, or other distances. It could even involve growth rates of bacteria, profit, velocity and acceleration. In many instances, like in question 10, it might involve topics from Paper 2, and therefore require the skill of integration of content from learners.

Problem-solving is part and parcel of Mathematics. A teacher cannot prepare learners for every specific context that may be targeted, but a teacher can help the learner to develop the skills needed. And prepare them for the fact that there might even be integration with Paper 2 topics in Paper 1, so that it will not surprise them so much that it would influence their ability to answer that question as good as possible.

QUESTION 11
COUNTING PRINCIPLES

	11.1.1	11.1.2	11.2	**Total**
Maximum mark	2	2	3	**7**
Average mark	0,4	0,5	0,2	**1,1**
Average %	20%	25%	8%	**16%**

A rather disappointing performance in this question.

QUESTION 11.1.1:

Skill tested:
Determining the number of unique 5-codes that can be formed if digits may be repeated.

Observations regarding responses:
- Candidates from certain centres all or almost all could answers this question correctly; and candidates from some other centres not at all. It is quite clear that probability is taught very well in a certain percentage of our schools in the province, and not effectively in another group of schools.
- Some candidates gave an answer of 5^7, instead of 7^5.
- It appears as if some candidates do not understand the process of selecting digits for a code; and the implication of allowing repetition of digits.

QUESTION 11.1.2:

Skill tested:
Determining the number of unique 5-codes that can be formed if digits may not be repeated.

Observations regarding responses:
- Performance in this question was disappointing. The same applies as in question 11.1.1: that candidates from some centres could all answer the question and that those from other centres were very confused.
- It appears as if some candidates applied rules without real understanding. As a result they gave an answer of 7! instead of $7\times6\times5\times4\times3$.

QUESTION 11.2:

Skill tested:
Calculating the number of unique 3 digit codes that can be formed, given specific restrictions.

Observations regarding responses:
- Very poorly answered.
- Some candidates gave the answer as . $7!\times2!\times1!$, instead of $7\times2\times1$.
- Some candidates misinterpreted the information: "The code is divisible by 5." They did not realise that the implication is that the code has to end on a 0 or a 5; and instead divided the number of codes by 5.

Suggestions for improvement in teaching and learning:

✓ Instead of teaching learners which rules apply in which type of situations in the teaching of counting principles, rather aim at them understanding the situations and processes so well that they can reason out which calculations need to be done. It is a much more effective way of teaching. Then you don't need to try to do all the different sums that have been asked before, and they don't need to stress to remember what to do all the time. And then a candidate will not write 7! instead of 7; or write 5^7, instead of 7^5, etc.

QUESTION 12
PROBABILITY: MUTUALLY EXCLUSIVE EVENTS and GIFT BAGS

	12.1	12.2	**Total**
Maximum mark	3	6	**9**
Average mark	1,7	0,2	**1,9**
Average %	57%	3%	**22%**

QUESTION 12.1:

Skill tested:
Applying the addition rule in probability for mutually exclusive events.

Observations regarding responses:

- Fairly well answered.
- Some candidates rounded off the answer of 0,29 to 0,3. The instruction is to round off only when necessary and then to two digits, so this was incorrect.
- Some candidates used the addition rule in probability, i.e. $P(A \text{ or} B)=P(A)+P(B)-P(A \text{ and } B)$, but then did not realise that $P(A \text{ and } B)=0$. They therefore couldn't calculate the value of y.

QUESTION 12.2:

Skill tested:
Problem-solving using a tree diagram.

Observations regarding responses:

- Most of the candidates did not attempt this question. It is a higher level question, requiring candidates to translate a word problem into Mathematics.
- Very few candidates could draw a correct tree diagram to represent the given information, especially the concept of selecting an object without replacement.

Suggestions for improvement in teaching and learning:

✓ In the teaching of probability in grades 10 and 11 the emphasis should be not on remembering formulas, but on a practical **understanding** of the meaning of concepts like mutually exclusive, complementary, independent, etc. mean. For $P(A \text{ or} B)=P(A)+P(B)-P(A \text{ and } B)$ not to just be a formula on a formula sheet, but that this formula will correspond to a picture in the mind of the learners.

✓ Tree diagrams are very useful in studying probability concepts. It is a way of listing all the possible outcomes in an orderly and structured way. It helps one to get clarity concerning the possible combined outcomes of a sequence of events; and the probability of each of the combined outcomes. It is well worth it to introduce tree diagrams when beginning to teach probability in gr. 10, and to use them regularly throughout the teaching of this section in FET Mathematics.