PRINCIPAL EXAMINER'S REPORT

BOTSWANA
EXAMINATIONS
COUNCIL

JCE MATHEMATICS

2022

PAPER 2

General Comments

The 2022 performance of candidates in Mathematics Paper 2 was at a lower threshold than what was anticipated. There is still a need for Centres to address some anomalies which have been depicted by scenarios where some candidates continue to use the wrong methods for some questions, while others show a lack or no response to some questions. Most of the candidates seemed to perform well in Section A whereas in Sections B and C candidates randomly/ haphazardly scored fewer marks without the consistency experienced in the previous section A. Questions dealing with graphs were the most challenging for candidates to apply themselves to.

Comments on specific questions

Section A

The questions in this section were fairly done though some of the candidates did not have adequate basic computational skills when it came to manipulating numbers and some operations.

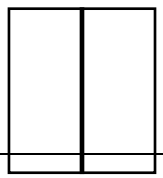
1	The question was fairly done. Most of the candidates were able to give the correct numbers, generally, it showed that our candidates were not well conversant with rectangle numbers. Some candidates just listed all the numbers given. **Answer**: 15, 36
2	(a) The question was poorly done, candidates could not express 3.43 in 24-hour notation instead they combined both 12-hour and 24-hour notation in their representation. e.g., 1543p.m. **Answer:** 1543 hours (b) It was poorly done; Most of the candidates could not convert from hours to minutes for instance 3:43 - 1:57 gave 1:86, which was converted to time as 2:26 p.m. There were just subtracting like ordinary numbers and failed to apply the correct processes of subtracting time.

	Answer: 1346 hours
3	The question was fairly done. However, most of the candidates treated 1 as a prime number hence they multiplied the correct prime numbers by 1 which led them to express 75 as the product of its prime factors as $3\times5\times5\times1$ which was incorrect. Some were just listing the numbers 3, 5 and 1 without expressing the factors as a product. **Answer:** 3×5^2
4	It was poorly done. Most candidates could not write the given number in standard form, which follows a set of certain rules; that is any whole number can be expressed as a decimal number between 1.0 and 10 and multiplied by the power of ten. The most common answers were 165×10^3, 16.5×10^4, 165×10^5 and 16500010^3. **Answer:** 1.65×10^5
5	The question was poorly done as most of the candidates calculated the area of a triangle, some calculated the hypotenuse using the Pythagoras rule when the question required the angle marked ***x***. Some candidates who calculated the angle correctly concluded wrongly by making a premature estimation of the answer as 62^0 instead of leaving it in one decimal point or three significant figures as per expectation. A few candidates' wrong answers showed evidence of wrong usage of other calculator modes, like radians and Grads, rather than degrees which led to the loss of marks. **Answer:** 61.9^0
6	The question was poorly done as the majority of the candidates calculated the volume of the cuboid rather than the total surface area as seen by their wrong answers 1080 cm^2. As for the few who made an attempt to calculate the total surface area correctly, they omitted the area of rectangles of dimensions 18 *cm* by 10 *cm* and presented 336 cm^2 as their wrong answer.

	Answer: 696 cm^2
7	The question was poorly done; it was observed that most of the candidates calculated either the midpoint or the gradient of a line for the given two points. A handful of candidates who had calculated using the correct formula and values only missed upon presenting their solution in two significant figures instead of three, 5.8, which did not score for accuracy marks since it was not meeting the required estimation standards for numbers without a terminating point. **Answer**: 5.83 units
8	The question was well done; the Majority of the candidates realised that the given angles, 73^0 and y, in the problem in question were interior angles formed between a transversal line and two parallel lines, and that they added up to 180^0. As such most candidates were able to subtract 73^0 from 180^0 to get the required angle. **Answer:** 107^0
9	It was poorly done; factorization by grouping was a challenge to most of the candidates as they could not correctly collect like terms. Some candidates only factorized numbers without variables, $2(2a+ap)+3(2q+pq)$, and did not know how to proceed thereafter, while others managed to factorise the algebraic expression up to the first stage, $2a(2+p)+3q(2+p)$, but could not figure out to factorise further so that they could just remain with a product of two algebraic expressions. **Answer:** $(2a+3q)(2+p)$
10	The question was fairly done. Some candidates were able to correctly associate the sector angle 80^0 for groceries with 360^0 to determine the representation ratio for groceries thereafter multiplying that ratio with Lethabo's salary of P4 320. A few candidates considered the sector angle given as if it's a percentage rather than an angle as such they divided by 100 to find the ratio thereafter multiplied by the salary which yielded an incorrect answer.

	Answer: P 960
11	The question was poorly done; Most of the candidates calculated the amount of depreciation using the 7.3% depreciation given in the question properly and presented that, P25 550, as their answers which were wrong since they were supposed to have subtracted the calculated value from the initial June 2017 car value of P350 000. **Answer:** P 324 450
12	It was poorly done; A good number of candidates could not demonstrate adequate skills in the construction item as not much effort was made to draw a triangle with the required specified angles of *ABC* and *BAC* with 78^0 and 50^0 respectively, but rather could only correctly draw the straight-line *AB* which was *8cm*. Some candidates could not use the protractor instrument for measuring angles properly as most triangles drawn were having wrong angles which were haphazard measurements. Some candidates were failing to label the diagram correctly as they confused the angles given in the question, as such candidates should be extra careful when labeling diagrams. **Answer:** *Correct triangle drawn* with *AB* = 8 *cm*, Angle *ABC* = 78^0 and angle *BAC* = 50^0
13	(a) It was fairly done; Some candidates were able to write a 2 by 1 column vector to represent vector *AB* but could not differentiate the representation of the units of the vector for the x – axis to that of the y – axis as a result they exchanged the values of 4 and 3 to get $\begin{pmatrix}3\\4\end{pmatrix}$, which was incorrect. Some candidates could not realize that the path of the vector only had positive movements on both axes, hence giving a representation of negative numbers in their column vectors which were wrong answers; $\begin{pmatrix}-3\\4\end{pmatrix}$, $\begin{pmatrix}-3\\-4\end{pmatrix}$ and $\begin{pmatrix}3\\-4\end{pmatrix}$. **Answer:** $\begin{pmatrix}4\\3\end{pmatrix}$ (b) It was poorly done; Most of the candidates were able to recognize the fact that they were expected to multiply the answer obtained from part (a) with a scalar quantity of 4, nonetheless, they could not calculate the correct values for the 2 by 1 column vector

	expected due to initially not being able to give the correct vector from part (a). At least it was evident that some candidates knew the concept of multiplying a vector by a scalar. **Answer:** $\begin{pmatrix}16\\12\end{pmatrix}$
	Section B
14	(a) The question was fairly done; Some candidates were able to recognize that the correct transformation was reflection but could not make a fully accurate description due to lack of skill in writing an identified line of reflection in algebraic form as was seen by wrong responses such as $y=1$. Candidates confuse algebraic equation representing the x – axis and that of the y – axis, and vice versa. **Answer:** *Reflection, Line of reflection* $x=1$ (b) It was poorly done; most candidates could relate to the concept of rotation but neglected the aspect of angle of rotation as candidates used 180^0 to rotate rather than 90^0 clockwise. Some candidates reflected Triangle A using x – axis as the line of reflection instead of transforming it by rotation which was wrong. **Answer:** ***Correctly drawn Triangle C*****;** *(-1, 2), (-1, 4) and (-4, 2)*
15	(a) It was well done; most candidates were able to associate the 42% with the flavoured water as expected and went on further to calculate 42% of 200 bottles of water to correctly obtain the number of bottles that contained flavoured water. **Answer:** 84 (b) It was poorly done; most of the candidates were able to notice that the fraction of plain water given, which was $\frac{10}{29}$, was to be multiplied by the number of bottles of water but could not identify the correct number of bottles of water to be used. Most candidates incorrectly used the total number of bottles of water, 200, instead of the number of bottles containing plain water *only* which was supposed to have been the difference of total number of water bottles and the number of water bottles containing flavoured water which led to a wrong outcome.

	Answer: 40
16	(a) The question was well done; most of the candidates were able to associate the properties of the diagram of the prism given in the question to a correct prism name required in the question. There were a few instances where some candidates gave their wrong answers as triangle prism, trapezium prism and rectangular prism. **Answer:** *Triangular prism* (b) The question was fairly done; some candidates could not connect the dimensions given in the question correctly with calculating the cross-sectional area of a prism since they just simply multiplied the three dimensions given together without considering the fact that it would yield a value for a volume rather than an area in spite of the fact that the question was very clear as to what value was to be calculated; cross-sectional area of the triangular prism. Some candidates ignored the shape given and simplistically used the formula for calculating volume of rectangular prism which was not correct. **Answer:** *Cross-sectional area* = $\frac{1}{2}\times 12\times 5$ = 30 cm^2 (c) The question was poorly done. Most candidates confused the calculation of the volume of a rectangular prism with that of a triangular prism hence wrongly applied the formula by substituting all the values given in the prism in question to obtain their wrong answer. A handful of candidates could not even make an attempt to answer the question but rather left the answer space blank. **Answer:** *Cross-sectional area* = $\frac{1}{2}\times 12\times 5\times 23$ = 690 cm^3 (d) It was poorly done. Majority of the candidates did not know what was expected of them to present as their answer since there were varied responses such as some candidates drawing the net of a prism; drawing a triangle which is a front elevation; drawing of a parallelogram or rectangle which is a side elevation. **Answer: congruent triangles** 

17	(a) It was well done. Most candidates were able to identify mode from the given distribution. There were a few candidates who wrote the correct number as the most frequently appearing number but presented it twice as a list, 495, 495 as their answer, which showed lack of understanding of the concept to some extent. Some candidates wrote 532 while others calculated mean and median of the distribution which was incorrect. **Answer:** 495 (b) It was well done. Most candidates were able to calculate the sum of the numbers in the distribution and divide it by the total frequency of numbers in the distribution accurately while there were a handful of candidates who only added the numbers in the distribution correctly and thereafter did not divide by anything which was an incomplete process. Some candidates were not as diligent since a few of them misread the numbers to be added from the distribution leading to wrong answers. **Answer:** 458
18	(a) It was poorly done. Most candidates did not virtualize the dimension of a rectangle as such they merely added the two algebraic expressions representing the width and the length of the sides of the shape and went no further, which was incorrect. Some candidates could not collect like terms correctly resulting in the wrong answer. **Answer:** $8f-8$ (b) It was well done. The majority of the candidates were able to realise that the algebraic expression for the perimeter of a mirror obtained in part ***(a)*** was to be equated to the value of the perimeter of the mirror, 248, given in this part of the question. Some candidates had errors emanating from their part (a) mistakes. **Answer:** $8f-8=248$ (c) It was poorly done. Most of the candidates could notice that there was need to collect like terms and make ***f*** the subject of the formula for the equation obtained in part (b) but committed various errors as they manipulated the equation. Some candidates

	could not collect like terms correctly whereas some candidates used the wrong operation of subtracting 8 on both sides of the equation, $8f - 8 = 248$, instead of adding to the equation. **Answer:** *f* = 32 cm (d) It was well done. Most candidates were able to correctly substitute the values they obtained from part (c) into the algebraic expression, (*3f – 4*) *cm*, of the length of the mirror even though their values may have been inaccurate for one reason or the other. **Answer:** 92 cm
19	(a) It was well done. The majority of the candidates were able to multiply the number of pairs for the black shoe laces with the variable, *x*, representing the price for each pair to calculate the total price for four shoe laces. There were a few incidents of some candidates writing equations instead of expected expressions which were wrong such as $x = 4x$, $x + 4 = 4x$, and some wrong expressions; 4^x, x^4, $4px$ and $x + 4$. Some candidates could not realise that the product of a number and a variable does not require the use of a multiplication operation sign between them, $4 \times x$, even though the marks were not lost. **Answer:** 4x (b) It was well done. The majority of the candidates were able to multiply the number of pairs for the white shoe laces with the variable, *y*, representing the price for each pair to calculate the total price for three shoe laces. There were a few incidents of some candidates writing equations instead of expected expressions which were wrong such as $y = 4y$, $y + 4 = 4y$, and some wrong expressions; 4^y, y^4, $4py$ and $y + 4$. Some candidates could not realise that the product of a number and a variable does not require the use of a multiplication operation sign between them, $4 \times y$, even though the marks were not lost. **Answer:** 4y

(c) It was well done. Majority of the candidates were able to realise that the algebraic expressions for the total price of Lerona's four black shoe laces and the total price for the three white shoe laces added together were of equal value to 39 Pula. Despite of the fact that some candidates had wrong expressions in part (a) and (b), they were able to add the two expressions together and equate to 39. There were a handful candidates who interchanged the number of pairs for black shoe laces with that of white shoe laces or prices for black shoe laces and white shoe laces which led to incorrect equations. Some common wrong answer was $3x + 4y$.

Answer: $4x + 3y = 39$

(d) It was well done. Most of the candidates were able to write the correct sum of algebraic expressions for the total price of Papiki's two black shoe laces and the total price for a pair of white shoe laces equated to the value of 17 Pula; a mathematical representation of Papiki's expenditure. There were a handful of candidates who interchanged the number of pairs for black shoelaces with that of white shoe laces or prices for black shoe laces and white shoe laces which led to incorrect equations. Some candidates wrote correct expressions and could not continue further to equate it to 17 Pula, which resulted in their answers being unacceptable. One of the common wrong answers was $x + 2y$.

Answer: $2x + y = 17$

(e) It was poorly done. Most of the candidates were able to demonstrate their understanding of making the coefficient of the variable to be eliminated being the same in both equations from parts (c) and (d) but could not manipulate the resolved values correctly due to haphazardly subtracting the left-hand sides and right-hand sides of the equations without maintaining the order in which the terms are arranged; $6y - 4y = 68 - 78$. Some candidates were able to make variables to be eliminated the same but rather used addition instead of subtraction to get rid of one of the variables which was an inappropriate operation to use. A handful of cases were observed where candidates could not correctly

	resolve the multiplication of numbers in the equation notwithstanding having chosen the right factors to use for multiplying the equations before elimination, which resulted in wrong outcomes. **Answer:** $x = 6$ and $y = 5$
20	(a) It was poorly done. Most of the candidates were able to identify the angle and radius to be used for calculation of arc *KT* but rather used formula for the area of a sector instead of length of an arc which was incorrect. Some candidates had a wrong formula used as they left out the constant 2 in the correct formula and as such, they wrongly captured it as $\frac{56}{360} \times \pi \times radius$ confusing it with one when a diameter is used. **Answer:** 7.13 cm (b) It was fairly done. Some candidates were able to notice that the perimeter of the sector *OKT* is obtained by adding two radii, 7.3 cm, and the length of the arc *KT* together and as such even though their part (a) was wrong, they used the value correctly. Some candidates calculated the area of the sector instead of calculating the perimeter of the sector. Some candidates wrongly used angle, 56, as another measurement to be added for the calculation of the perimeter of the given sector. **Answer:** 21.7 cm
21	(a) The question was poorly done. Most candidates were able to identify the given values to substitute against the correct variable but ignored the appropriate use of brackets such that it affected the resolving of the mathematical statement. Some candidates could not resolve properly and obtained wrong answers such as – 36, – 51, – 60 and 44. **Answer:** 39 (b) It was poorly done. Most candidates were trying to manipulate the formula to make y the subject of the formula but confused operations required to move terms around such

	as the following: subtracting 7 instead of adding it on both sides; subtracting the coefficient of y, which is 4, on both sides instead of dividing with it. **Answer:** $y = \frac{w+7}{4}$
22	(a) It was fairly done. Most candidates were able to calculate the angle of *NRT* by subtracting 154^0 from 180^0 but could not express the angle as a bearing since there is an expectation of writing it in three digits. **Answer:** 026^0 (b) It was poorly done. Most of the candidates were able to choose the appropriate method of Pythagoras Theorem to use but confused the substitution of sides which are in the right angled triangle *RST*. Some candidates tried using trigonometric ratios which proved to be an insurmountable challenge. Most common wrong working was $\sqrt{10.6^2 + 6.3^2}$. **Answer:** 8.52 cm
23	(a) It was well done. Most candidates were able to complete the cumulative frequency table using the frequency table with the distribution showing heights of participants at a darts game competition. **Answer:** 68 and 70 (b) It was well done. Most the candidates were able to plot all the given points including those that they had to compute and further on drew the required cumulative curve even though there were few instances where some candidates used a ruler to join the different points rather than a free hand, which was not accepted as correct. **Answer:** *A correct cumulative curve with points; (150, 0), (155, 4), (160, 11), (165, 23), (170, 43), (175, 56), (180, 63), (185, 68) and (190, 70).* (c) It was poorly done. Most candidates could not interpret the graph they have drawn to calculate the median by correctly extrapolating from the cumulative graph, instead they

	used the values in the $x-axis$ as their distribution by simply identifying the middle number after arranging them in order, resulting in 170 as their answer which was incorrect. **Answer:** 167 (± 1) (d) It was fairly done. Most of the candidates could not use the cumulative graph to estimate the number of participants with heights 177cm or less as they randomly gave wrong answers which had no mathematical basis. Some candidates did not attempt the question at all indicating that the concept could have been somewhat too abstract for them, hence Centres may have to pay attention to interpretation of cumulative graphs. **Answer:** 59 (± 1)
	Section C
24.	It was fairly done. Most candidates were able to determine a relationship between the letters and numbers given to form different equations and patterns, hence candidates were able to correctly match a pair of numbers, 7 and 10, with letters, G and J, respectively to calculate the sum of G and J. **Answer:** 17
25.	It was well done. Most candidates were able to deduce what numbers could be used in the incomplete equations which were given both horizontally and vertically to ensure that upon using them the conditions were satisfied. **Answer:** 5 - 3 = 2 + + 5 + 3 = 8 = = 10 6

<table>
<tr><td>26.</td><td>The question was well done. Most candidates were able to establish that the number inside the circle is a summation of the numbers outside the circle.

Answer: x = 27, y = 12</td></tr>
<tr><td>27.</td><td>It was poorly done. Most candidates were able to determine the difference between two consecutive terms to establish what the rule is, but they could not apply the general rule for the sequence to find the next two missing terms of the sequence. Most the candidates found 32 and 64 as their next two terms, which was incorrect.

Answer: 68 and 132</td></tr>
<tr><td>28.</td><td>It was poorly done. Most candidates could not associate the ages given with the condition of having the ages yielding a product of 36 while some of those who provided products of 36 could not satisfy other conditions with regard to the ages of Lema, Gosetse and Phemo. Common wrong answers were Lema = 9, Gosetse = 4 and Phemo = 1 or Lema = 9, Gosetse = 2 and Phemo = 2.

Answer: Lema = 6, Gosetse = 3 and Phemo = 2.</td></tr>
<tr><td>29.</td><td>This question was poorly done. Most candidates were able to ensure that the numbers along each side of the square added to 150 but missed the point that the numbers should have been coming from the given set, hence candidates brought in their own numbers from nowhere. As for some candidates, they repeated the use of some of the given numbers to obtain the required summation, yet the rule was to use each number provided once. The number 90 was commonly used wrong number.

Answer:
<table>
<tr><td>30</td><td>40</td><td>80</td></tr>
<tr><td>50</td><td></td><td>10</td></tr>
<tr><td>70</td><td>20</td><td>60</td></tr>
</table>
</td></tr>
<tr><td>30.</td><td>This question was poorly done. Most candidates could not recognize the relationship between number of goats for Thuo and Pako such that they could not even form</td></tr>
</table>

equations, hence they were providing wrong answers at random. Some candidates exchanged the number of goats that Thuo expected with those that Pako had, and vice versa which could not earn a mark.

Answer:

	Before	**After**
Thuo	10	30
Pako	40	60