3.0 PART ONE: ANALYSIS OF DIFFICULT QUESTIONS

3.1 MATHEMATICS (121)

In the year 2021 Mathematics Alternative A was tested in two papers. **Paper 1 (121/1)** and **Paper 2 (121/2)**. Each paper consisted of two sections: Section I (50 marks) consisting of 16 compulsory short answer questions of not more than four marks each and Section II (50 marks), with eight questions of 10 marks each where candidates answer any five. Paper 1 (121/1) tests mainly Forms 1 and 2 work while Paper 2 (121/2) tests mainly forms 3 and 4 work of the syllabus.

This report is based on an analysis of performance of candidates who sat the year 2021 KCSE Mathematics Alt A.

3.1.1 Candidates' General Performance

The table below shows the performance of both papers in the last five years.

Table 7: Candidates' Performance in Mathematics Alt A for the last five years, 2017– 2021

Year	Paper	Candidature	Maximum Score	Mean Score	Standard Deviation
2017	**1**	**609525**	100	24.49	22.03
	2		100	26.47	22.43
	Overall		**200**	**50.95**	**43.46**
2018	**1**	**658904**	100	24.07	21.16
	2		100	28.82	20.85
	Overall		200	**52.88**	**41.1**
2019	**1**	**694445**	100	31	24.037
	2	**694347**	100	23	20.904
	Overall		**200**	**55.08**	**43.91**
2020	**1**	**742796**	100	22.27	19.41
	2	**742760**	100	14.45	14.97
	Overall		**200**	**36.72**	**33.45**
2021	**1**	**822376**	100	23.66	19.87
	2	**822242**	100	16.39	15..27
	Overall		**200**	**40.04**	**33.98**

From the table the following observations can be made:

(i) There was an improvement of 1.39 marks in the mean mark of 121/1 compared to the previous year 2020.

(ii) In 121/2, there was an improvement of 1.94 marks in the mean mark compared to the previous year 2020.

(iii) The overall mean mark out of 200 improved by 3.32 marks compared to the previous year 2020..

3.1.2 Individual Question Analysis

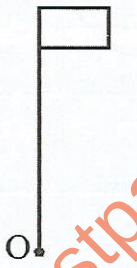
The following is a discussion of some of the questions in which the candidates had major weakness in, as a result of which these questions were poorly performed. The discussion is based on observations made by examiners extracted the chief examiners reports.

3.1.3 Mathematics Paper 1 (121/1)

In section 1 of 121/1, questions 1, 2, 8, 10, 11, 12, and 13 were popular among the candidates. In Section II, questions 19, 23 and 24 were the most popular among the candidates. Questions 3, 12, 15 and 17 were said to have been relatively poorly performed.
Below is a discussion on the questions that were poorly performed.

Question 3

Complete the figure below to show a rotational symmetry of order 3 about O. (3 marks)

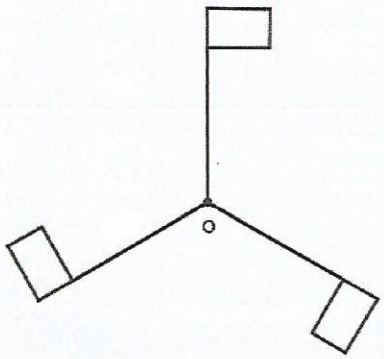


The question tested on order of rotational symmetry.

Weaknesses

- Lack of knowledge on order of rotational symmetry.
- Lack of required level of accuracy.

Expected response

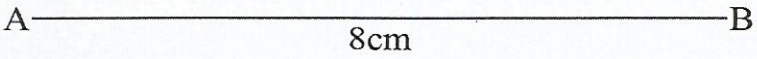


Advice to teachers

Teachers need to expose learners to real life application of the concept of order of rotational symmetry. The concept occurs in wind mills, air fans and in nature. Emphasis on basic transformations taught in Form 2 needs not be overstated. High degree of accuracy during construction is a requirement.

Question 12

Line AB drawn below is a side of a trapezium ABCD.



(a) Using a ruler and pair of compasses only, complete trapezium ABCD in which AB is parallel to DC, $\angle BAD = 67.5°$, AD = 5 cm, BC = 5.5 cm and $\angle ABC$ is acute. (3 marks)

(b) Measure the length of DC. (1 mark)

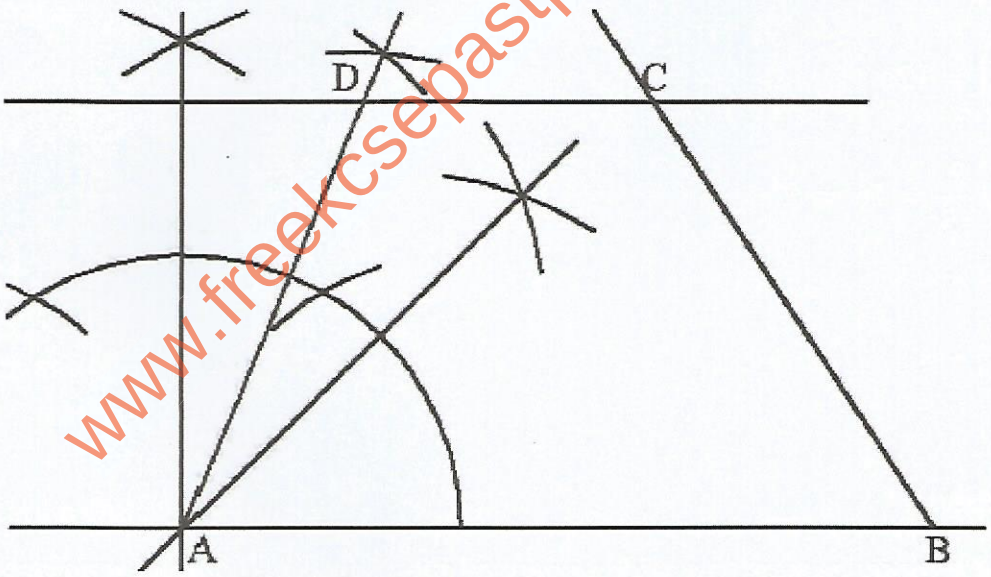
The question tested on construction of quadrilaterals.

Weaknesses

- Most candidates could not construct an angle of $67.5°$.
- Other candidates could not construct parallel lines, passing through a given point.

Expected response

(a)



(b) DC = (3.1 ± 0.1) cm

Advice to teachers

Teachers should emphasize to learners the importance of drawing a sketch first before they start any construction. The accuracy of constructed special angles should be within $\pm 1°$ that of the actual value. The evidence of actual construction of angles is arcs which must be seen. The proper procedure of construction of special angles is also checked. The accuracy of constructed lengths should be within $\pm$ 0.1 cm that of the required length.

Question 15

Solve the equation $8^{x+1} - 2^{3x-1} = 120$. (4 marks)

The question tested on indices.

Weaknesses

- Many candidates were unable to interpret and apply laws of indices in reverse form.
- Many learners attempted to use logarithms tables or calculators to assist solve the equation.
- Some candidates left their answers as improper fractions.

Expected response

$8^{x+1} - 2^{3x-1} = 120$

$(2^3)^{x+1} - 2^{3x-1} = 120$

$2^{3x+3} - 2^{3x-1} = 120$

$2^{3x} \times 2^3 - \frac{2^{3x}}{2} = 120$ (reversed laws of indices)

$2^{3x}\left(2^3 - \frac{1}{2}\right) = 120$

$2^{3x} = 120 \times \frac{2}{15} = 16 = 2^4$

$3x = 4$

$x = 1\frac{1}{3}$

Advice to teachers

Teachers should expose learners to a wide variety of questions on equations requiring application of indices. Teachers also need to cite limitations of calculators and logarithm tables in solving some equations. The errors introduced by use of tables and calculators needs to be discussed.

Question 17

A factory packs fruit jam in cylindrical tins of radius 5 cm and height 15 cm. The tins are then packed into rectangular cartons each measuring 60 cm long, 30 cm wide and 30 cm high.

(a) Determine the maximum number of tins that can be packed in one carton. (2 marks)

(b) An empty carton and an empty tin weighs 560 g and 300 g respectively. The jam packed in one tin weighs 990 g. A pick-up which can carry a maximum of 600 kg is used to transport the jam. Determine the maximum number of cartons the pick-up can carry. (4 marks)

(c) The factory delivered a pick-up full of cartons of jam to a retailer. The factory sells one carton to a retailer for Ksh 2 880. The retailer sells each tin at Ksh 110.
Calculate the percentage profit made by the retailer. (4 marks)

Weaknesses

- A number of candidates had challenges arranging cylindrical tins in a cuboid.
- Some candidates had a misconception buy applying concept of volume in order to determine the number of tins
- A number of candidates had challenges interpreting "maximum" in 17(b).

Expected Response

(a) No. of tins $= \frac{60}{10} \times \frac{30}{10} \times \frac{30}{15}$

$= 6 \times 3 \times 2$

$= 36$

(b) Mass of tin and jam $= 990\text{ g} + 300\text{ g}$

$= 1290\text{ g}$

Mass of carton full of jam tins

$= (560 + 1290 \times 36)\text{ g}$

$= 47000\text{ g}$

$= 47\text{ kg}$

Let N be the number of cartons carried by pick up

$47N \leq 600$

$N \leq 12.76$

Max N $= 12$

(c) Retailers S.P

$$= \text{Ksh}(110 \times 36)$$

$$= \text{Sh } 3960 \text{ per carton}$$

$$\text{Retailers profit} = \text{Ksh}(3960 - 2880)$$

$$= \text{sh}1080$$

Retailers % profit

$$= \frac{1080}{2880} \times 100$$

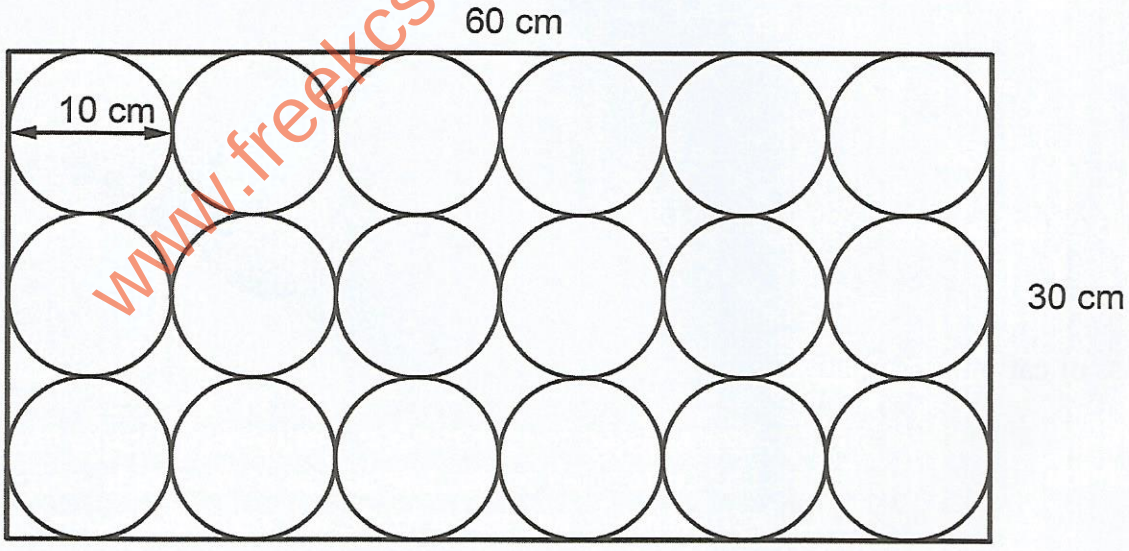
$$= 37.5\%$$

Advice to teachers

Teachers use practical packing of solids in similar and different shapes. Crates of soda or artistic diagrams can be used to explain why volume cannot be used to determine number of cylindrical tins in part (a) of the questions .

Teachers also need to expose learners to application of linear inequalities in real life situations.

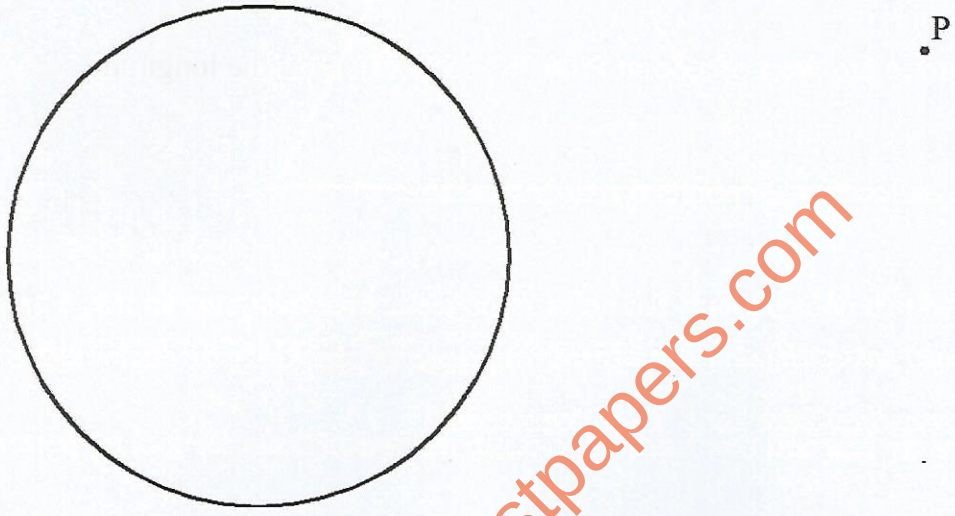
Example of artistic work - bird eye view of packed crate.



In section 1 of 121/2, questions all questions were equally popular among the candidates.
Questions 20 was popular among the candidates in Section II.
Below is a discussion on Q5,Q11, Q13, Q20 and Q24. These were identified by examiners as having been poorly performed.

Question 5

The figure below shows a circle and a point P outside the circle

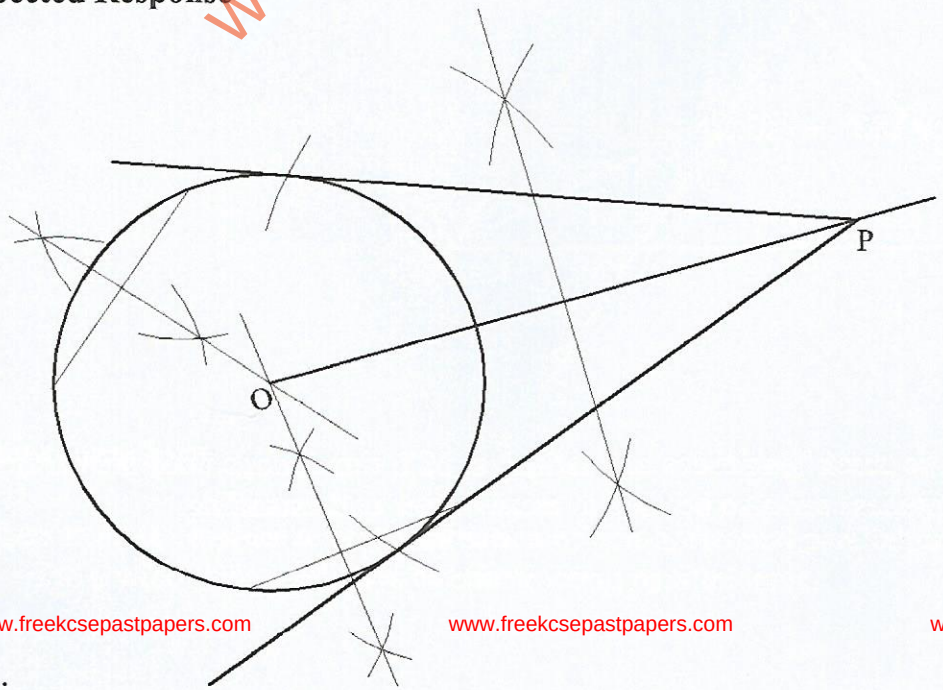


Using a ruler and pair of compasses, construct a tangent to the circle from P. (4 marks)
The question tested on construction of a tangent to a circle.

Weaknesses

- Most candidates failed to see the need to locate the centre of the circle.
- Many candidates could not construct the tangent.

Expected Response



Advice to teachers

Teachers need to emphasize on definitions. At the point of contact, a tangent to a circle makes an angle of 90° with the radius. The centre of the circle needs to be located if it has not been given to enable one construct a tangent.

Teachers need to connect angle properties of a circle to the procedure of constructing a tangent so as to help learners to make meaning of procedure.

Question 11

A point Q is 2000 nm to the West of a point P(40 °N, 155 °W). Find the longitude of Q to the nearest degree. (3 marks)

The question tested on location of points on earth's surface.

Weaknesses

Most candidates could not establish the required longitude. It can partly be attributed to effects of crossing of the International Date Line $(180°$ longitude$)$.

Expected response

Let θ = longitude difference between P and Q

$\theta \times 60 \cos 40 = 2000$

$$\theta = \frac{2000}{60 \cos 40}$$

$= 43.51°$

$155 + 43.51 = 198.51°$

Longitude of Q

$= 360° - 198.51°$ or $180° - \{43.51 - (180° - 155°)\}$

$= 161.49°$ E

$= 161°$ E

Advice to teachers

Teachers need to use models to teach longitudes and latitudes. ICT simulations with the earth as a globe (with latitudes and longitudes) can also be used to create better understanding.

Question 20

The table below shows income tax rates in a certain year.

Monthly taxable income in Kenya shillings	Tax rates
0 – 12 298	10%
12 299 – 23 885	15%
23 886 – 35 472	20%
35 473 – 47 059	25%
47 060 and above	30%

In the year, the monthly earnings of Kanini were as follows:

Basic salary Ksh 64 500

House allowance Ksh 12 000

Kanini contributes 7.5 % of her basic salary to a pension scheme. This contribution is exempted from taxation. She is entitled to a personal tax relief of Ksh 1 408 per month.

Calculate:

(a) Kanini's monthly taxable income. (2 marks)

(b) the tax payable by Kanini that month. (6 marks)

(c) Kanini's net pay that month. (2 marks)

The question tested on taxation of income in Kenya.

Weaknesses

- Many candidates failed to deduct pension contribution from taxable income.
- Many candidates rounded off money to the nearest shilling instead of cents.

Expected response

(a) Taxable income

$$= 64\,500 + 12\,000 - \frac{7.5}{100} \times 64\,500$$

$$= \text{Ksh } 71\,662.50$$

(b) Tax payable by Kanini

$$1^{st} \text{ slab} = 12298 \times \frac{10}{100} = 1\,229.80$$

$$2^{nd} \text{ slab} = 11587 \times \frac{15}{100} = 1\,738.05$$

$$3^{rd} \text{ slab} = 11587 \times \frac{20}{100} = 2\,317.4$$

$$4^{th} \text{ slab} = 11587 \times \frac{25}{100} = 2\,896.75$$

$$5^{th} \text{ slab} = 24603.5 \times \frac{30}{100} = 7\,381.05$$

Total tax = 15563.05

Tax less relief

= Ksh 15 563.05 – 1408

= Ksh 14 155.05

(c) Total deductions

$$= 14\,155.05 + \frac{7.5}{100} \times 64\,500$$

= 18 992.55

Net income = 64 500 + 12000 – 18 992.55

= 57 507.45

Advice to teachers

Teachers need to keep abreast with the current trends in taxation. (eg Most current taxation tables in use and other innovations in taxation). The question borrowed from the taxation method currently affecting all civil servants below 45 years who are making monthly contribution towards their pension. (Self-contributory pension scheme).

Question 24

A particle was moving along a straight line. The acceleration of the particle after t seconds was given by $(4t - 13)\ ms^{-2}$. The initial velocity of the particle was $18\ ms^{-1}$.

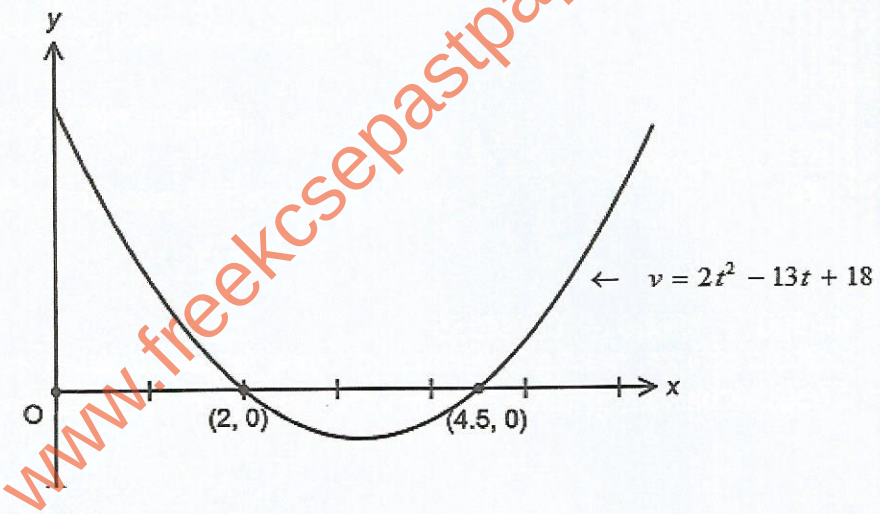
(a) Determine the value of t when the particle is momentarily at rest. (5 marks)

(b) Find the distance covered by the particle between the time t = 1 second and t = 3 seconds. (5 marks)

The question tested on interpretation of equations of motion.

Weaknesses

- In 24 (b), failure to interpret points where v = 0 from 22(a) as x- intercepts of the curve $v = 2t^2 - 13t + 18$.
- Many candidates could not establish that area in Q22 (b) was partly below x –axis and partly area above x- axis. This is in spite of having worked out the correct x- intercept of $v = 2t^2 - 13t + 18$ in Q22 (a). (See graph below)



Expected response

(a) $v = \int (4t - 13)\, dt$

$= 2t^2 - 13t + c$

when $t = 0, v = 18$

$18 = 2\times0 - 13\times0 + c$

$c = 18$

$v = 2t^2 - 13t + 18$

When $v = 0$

$2t^2 - 13t + 18 = 0$

$(2t - 9)(t - 2) = 0$

$t = 2$ or $t = 4.5$

b) Distance covered by particle

Area above x axis

$$\int_1^2 (2t^2 - 13t + 18)\,dt$$

$$= \left[\frac{2}{3}t^3 - \frac{13}{2}t^2 + 18t\right]_1^2$$

$$= \left[\frac{2}{3}\times 2^3 - \frac{13}{2}\times 2^2 + 18\times 2\right] - \left[\frac{2}{3}\times 1^3 - \frac{13}{2}\times 1^2 + 18\times 1\right]$$

$$= \left[\frac{16}{3} - 26 + 36\right] - \left[\frac{2}{3} - \frac{13}{2} + 18\right]$$

$$= 15\frac{1}{3} - 12\frac{1}{6}$$

$$= 3\frac{1}{6}$$

Area below x axis

$$= \left[\frac{2}{3}\times 3^3 - \frac{13}{2}\times 3^2 + 18\times 3\right] - 15\frac{1}{3}$$

$$= \left[18 - \frac{117}{2} + 54\right] - 15\frac{1}{3}$$

$$= -1\frac{5}{6}$$

$$= 1\frac{5}{6}$$

Total area

$$= 3\frac{1}{6} + 1\frac{5}{6}$$

$$= 5 \text{ m}$$

Advice to teachers

Curve sketching before calculation of area should be emphazised.

Conclusion

Major weaknesses have been observed in most areas of the syllabus for Mathematics Alt A. These areas include **Numbers** (Indices, inequalities), **Geometry** (General construction, construction of tangent to a circle from an external point, Loci, Longitudes and Latitudes), **Commercial Arithmetic** (income tax), **Measurements** (Mass), **Transformations** (Order of rotational symmetry) and **Integration** (application to area under a curve in kinematics).

Application of learned concepts to real life situations was observed to be a challenge to many candidates. To help learners understand the concepts, it is necessary to have more applications relating to real life situations in the course of the teaching and learning.