5.0 MATHEMATICS (121)

This Mathematics report is based on an analysis of performance of candidates who sat for the year 2008 KCSE Mathematics examination. Candidates were tested in most of the skills on the Bloom's Taxonomy on the cognitive domain. The KCSE Mathematics examination tested the candidates' abilities in two papers; ***Paper 1 (121/1)*** and ***Paper 2 (121/2***). The two papers are equally weighted and each is marked out of one hundred percent. The two papers supplement each other to cover the entire syllabus. It is hoped that this report will be of benefit to both the teachers and students in the teaching/learning process as well as in preparing candidates for future examinations.

5.1 CANDIDATES' GENERAL PERFORMANCE

The table below shows the overall performance of both papers for the past four years.

Table 10: Candidates' Overall Performance in Mathematics for the Last Four Years

Year	Paper	Candidature	Maximum Score	Mean Score	Standard Deviation
2005	1		100	19.95	19.38
	2		100	19.51	19.25
	Overall	**259,280**	**200**	**39.39**	**37.95**
2006	1		100	22.71	20.09
	2		100	15.36	15.97
	Overall	**238,684**	**200**	**38.08**	**35.00**
2007	1		100	19.55	10.09
	2		100	19.91	20.74
	Overall	**273,504**	**200**	**36.46**	**39.83**
2008	1		100	22.76	22.76
	2		100	19.82	19.56
	Overall	**304,908**	**200**	**42.59**	**41.53**

From the table above, the following observations can be made:

5.1.1 The overall mean in the Mathematics examination improved from ***36.46*** in the year 2007 to ***42.59*** in the year 2008.

5.1.2 The overall standard deviation in the Mathematics examination also improved in the year 2008 ***(41.53)***, when compared to the year 2007 ***(39.83)***.

5.1.3 There has been a significant increase in candidature over the years.

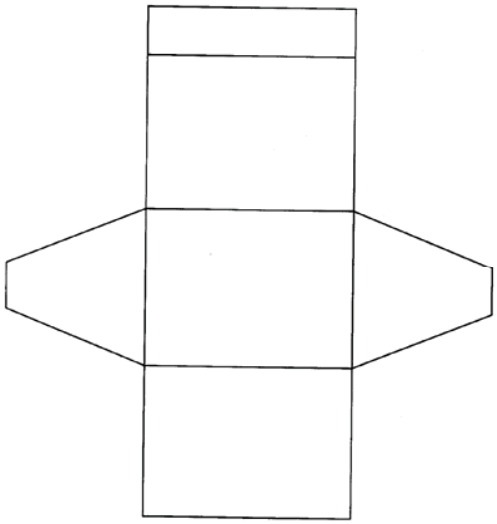
Questions in which candidates' performance was poor have been identified and are analyzed in detail in the discussion that follows.

5.2 PAPER 1 (121/1)

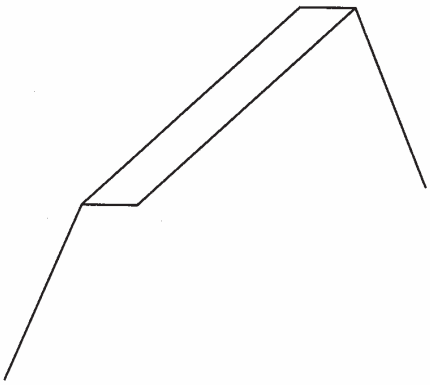
In this paper, candidates were required to answer all the questions in ***Section I*** and choose any five questions in ***Section II.*** It is important to note that candidates were not required to answer any extra questions in section II. Responses from candidates revealed that the following questions were most difficult: Questions ***5, 8, 10, 13, 20*** and ***21.***

Question 5

The figure below shows a net of a solid.



Below is a part of the sketch of the solid whose net is shown above.
Complete the sketch of the solid, showing the hidden edges with broken lines.

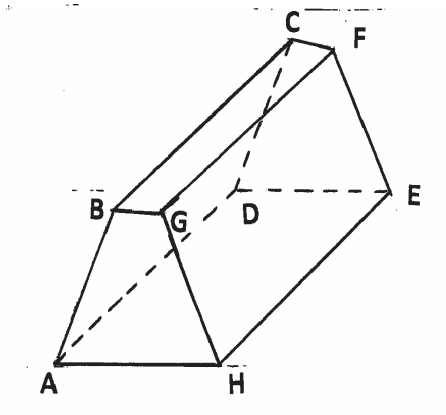


This question tested candidates' skills on construction of a solid. Given a part of a sketch of the solid and the net of the solid, candidates were required to complete the sketch.

Weaknesses

Most of the candidates were non-starters in this question. Majority of them could not draw the corresponding parallel and equal lines. Those who did were unable to indicate the hidden edges as demanded.

Expected Responses



Candidates needed to draw line CD parallel and equal to FE and complete the sketch with hidden edges dotted. The solid was to be drawn using a ruler.

Advice to Teachers

Teachers are advised to provide students with adequate practice in construction of solids given their nets.

Question 8

Line BC below is a side of a triangle ABC and also a side of a parallelogram BCDE.

Using a ruler and a pair of compasses only, construct:

(i) the triangle ABC given that $\angle ABC = 120°$ and AB = 6 cm

(ii) the parallelogram BCDE whose area is equal to that of the triangle ABC and point E is on line AB.

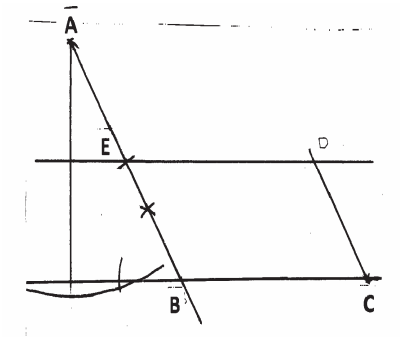
This question tested candidates' ability to construct angles using a ruler and a pair of compasses only.
Candidates were required to construct angle 120^0 on a given line BC and then construct the triangle ABC given that line AB = 6 cm. Candidates were then required to construct a parallelogram whose area equals that of triangle ABC.

Weaknesses

Majority of the candidates were not able to relate the triangle and the parallelogram given the same base and area.

Expected Responses

To start with, candidates needed to construct angle 120^0 and complete the triangle ABC to earn the first mark. Candidates were then expected to drop a perpendicular from point A to line CB produced height of triangle ABC, as shown in figure 2 below to obtain the height of triangle ABC.



Bisection of the height of triangle ABC will provide the height of the parallelogram. Candidates needed to determine point E and D and draw parallel lines EB and DC. Hence completion of the parallelogram BCDE.

Advice to Teachers

Teachers are therefore required to take students through such relationships.

Question 10

An angle of 1.8 radians at the centre of a circle subtends an arc of length 23.4 cm.
Find:

(a) the radius of the circle

(b) the area of the sector enclosed by the arc and the radii.

This question tested the candidates' knowledge on the radian measure as relates to the circle.

Weaknesses

Candidates had difficulties in using the relationship between degrees and radians.

Expected Responses

(a) Candidates were required to use the radian measure to find the radius of the circle,
$r = \frac{23.4}{1.8} = 13\ cm$.

(b) They were also required to find an arc length and area of an enclosed sector as follows:

Area of sector $= \frac{1.8}{2\pi} \times \pi \times 13^2 = 152.1 cm^2$

Advice to Teachers

Teachers are advised to teach in depth about the relationships between degrees and radians.

Question 13

A rectangular and two circular cut-outs of metal sheet of negligible thickness are used to make a closed cylinder. The rectangular cut-out has a height of 18 cm. Each circular cut-out has a radius of 5.2 cm. Calculate in terms of π, the surface area of the cylinder.

This question tested candidates' knowledge on surface area of a cylinder. Candidates were required to calculate the

surface area of the cylinder given the rectangular part and two circular cut-outs. The answer was to be left in terms of π.

Weaknesses

A good number of candidates did not follow the instructions after using the formula $SA = 2\pi r^2 + 2\pi rh$.

Expected Responses

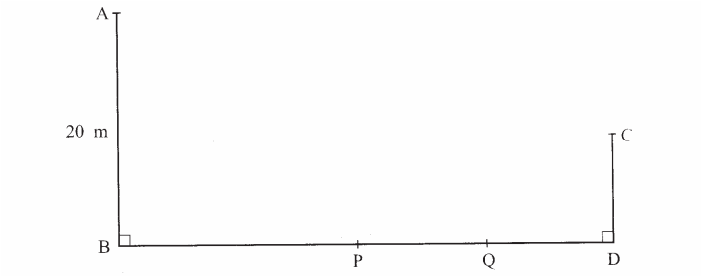
The area of the rectangular part (2 x 5.2 x π x 18 = 187.2π) was to be added to the area of the circular parts (2 x 5.22 x π = 54.08π) to obtain the surface area of the cylinder as 241.28π.

Advice to Teachers

Teachers need to give plenty of exercises to students on similar questions.

Question 20

The diagram below represents two vertical watch-towers AB and CD on a level ground. P and Q are two points on a straight road BD. The height of the tower AB is 20 m and road BD is 200 m.



(a) A car moves from B towards D. At point P, the angle of depression of the car from point A is 11.3°. Calculate the distance BP to 4 significant figures.

(b) If the car takes 5 seconds to move from P to Q at an average speed of 36 km/h, calculate the angle of depression of Q from A to 2 decimal places.

(c) Given that QC = 50.9 m, calculate:

(i) the height of CD in metres to 2 decimal places;

(ii) the angle of elevation of A from C to the nearest degree.

This question tested candidates' application skills on the concepts of angles of depression and scale drawing.

Weaknesses

Most candidates managed to score the first six marks only.

Expected Responses

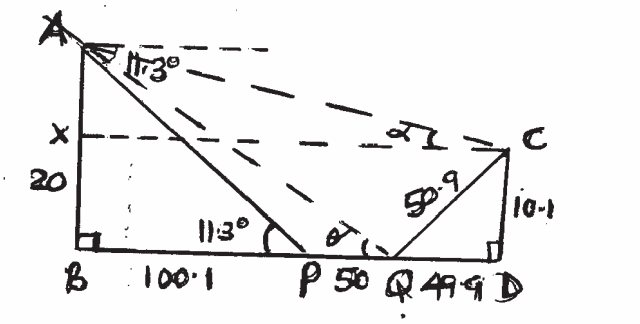
(a) Candidates were required to apply their knowledge of trigonometric ratios to calculate the distance BP:

$$\tan 11.3° = \frac{20}{BP} \Rightarrow BP = 100.1m$$

(b) Candidates needed to apply the conversion skills to calculate the distance PQ:

$$\text{PQ} = \frac{36x1000}{60x60}x5 = 50m$$

In order to conceptualize the required angle, that is, the angle of depression of Q from A, candidates needed to come up with the following sketch:



Thus, the distance BQ = 100.1 + 50 = 150.1m

Tan of the angle of depression = $\tan\theta = \frac{20}{150.1} \Rightarrow \theta = 7.5896426$

$\approx 7.59°$

(c) Candidates were required to calculate the height CD and the angle of:

(i) elevation of A from C as follows:

$$CD = \sqrt{50.9^2 - 49.9^2} = 10.03992 \approx 10.04m$$

(ii) The angle of elevation $(\propto)$ of A from C can be calculated as:

$$\tan(\propto) = \frac{9.96}{200} = 0.0498$$

$$\alpha = 2.8509745$$

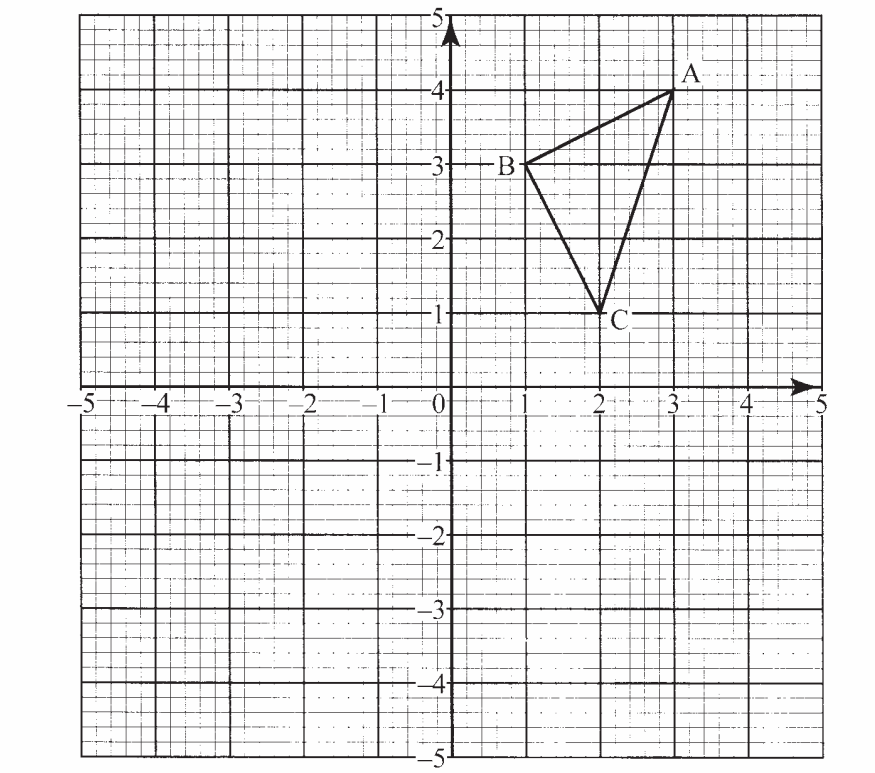
$$\approx 3^0$$

Advice to Teachers

Teachers need to ensure that students draw sketches that can help them answer such questions accurately.

Question 21

The diagram below shows a triangle ABC with A(3,4), B(1,3) and C(2,1).



(a) Draw ΔA'B'C', the image of ΔABC under a rotation of −90° about (0,0).

(b) Draw ΔA"B"C" the image of ΔA'B'C' under a reflection in the line y = x.

(c) Draw ΔA'"B'"C'", the image of ΔA"B"C" under a rotation of −90° about (0,0).

(d) Describe a single transformation that maps ΔABC onto ΔA'"B'"C'".

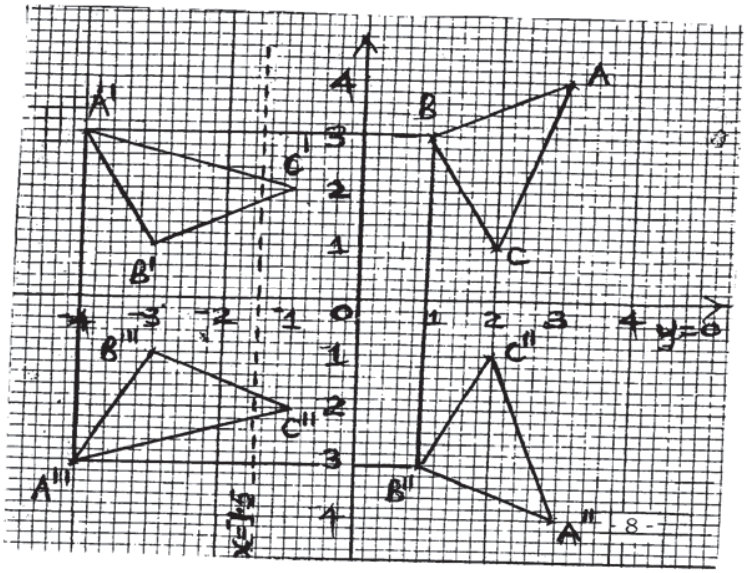
(e) Write down the equations of the lines of symmetry of the quadrilateral BB"A'"A'.

This question tested the candidates' knowledge of rotations and reflections. Candidates were required to display high skills on construction of images of objects after being subjected to given transformations.

Weaknesses

In this question most candidates were unable to obtain the correct equation in part (e).

Expected Responses



(a) The two marks were earned after correctly drawing the image $A'B'C'$, the image of the triangle ABC under a rotation of positive $90°$ about the origin. 1 mark was given in case only two vertices of the image $A'B'C'$ were correct.

(b) The two marks were earned for $A''B''C''$ correctly drawn.

(c) The two marks were awarded for $A'''B'''C'''$ correctly drawn.

(d) Candidates were required to describe a single transformation that maps triangle ABC onto $A'''B'''C'''$. The correct description was: a reflection in the line $y = -x$.

(e) The equations of the lines of symmetry of the quadrilateral $BB''A'''A'$ are:

$x = -1.5$ and $y = 0$.

Advice to Teachers

Teachers are advised to give more exercises for practice to students on the concept of transformation.

5.3 PAPER 2 (121/2)

This paper complements paper 1 in covering the KCSE Mathematics syllabus. The paper covers mainly Form 3 and 4 syllabi. The paper format is similar to that of paper 1. The following questions proved to be difficult, according to candidates' responses: Questions ***1, 3, 6, 12, 14, 21*** and ***23***.

Question 1

In this question, show all the steps in your calculations, giving the answer at each stage. Use logarithms correct to 4 decimal places, to evaluate

$$\frac{6.373 \log 4.948}{\sqrt{0.004636}}$$

This question tested candidates' ability to use logarithms in calculations of given operations.
Candidates were required to interpret 'log a' as a number in operations. They were to determine logarithms of the given numbers to 4 decimal places. They were required to also use logarithmic laws for multiplication, division and square roots.

Weaknesses

It is important to note that the question demanded displaying ***"all the steps"*** in the candidates' calculations, giving the answer at each stage. Instead, most candidates used calculators to get the square root or product in the numerator before applying logarithms.

Expected Responses

Candidates needed to find the log (log 4.948) as log = $0.6944 = \bar{1}.8416$. Again, they were to obtain $\log\sqrt{0.004636} = \bar{2}.8331$. Eventually, candidates were expected to obtain 64.98 as the correct answer.

Advice to Teachers

Teachers are advised to give students more practice on use of ***"log a"*** as a number in operations, and use of negative characteristics.

Question 3

Line AB given below is one side of triangle ABC. Using a ruler and a pair of compasses only:

(i) Complete the triangle ABC such that BC = 5 cm and $\angle ABC = 45°$.

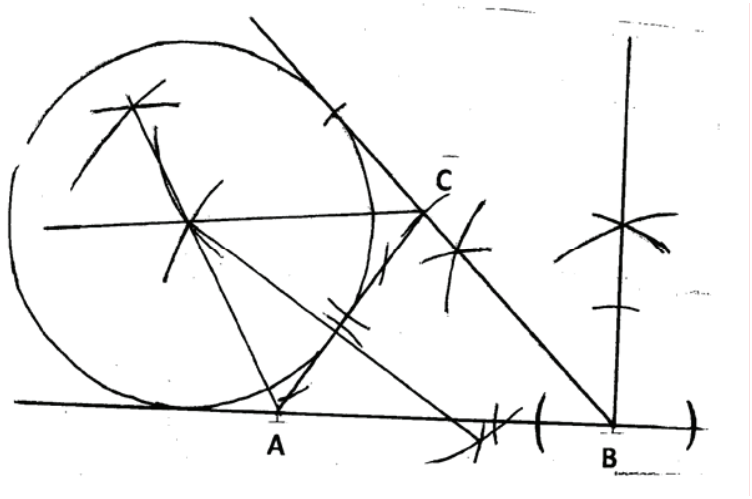
(ii) On the same diagram construct a circle touching sides AC, BA produced and BC produced.

This question tested candidates' ability to construct an escribed circle. Candidates were required to construct a triangle ABC first as per the given specifications. Thereafter, they were to construct the escribed circle along the side AC.

Weaknesses

Most candidates were unable to draw the sides BA produced and BC produced. Some were not able to construct the circle due to failure to determine the centre of the circle.

Expected Responses



To construct the triangle, candidates needed to construct angle $45°$ at B and locate point C, 5cm from B. To construct the escribed circle along AC, sides BA and BC produced, bisect the angle at A and C respectively to determine the centre of the circle. To determine the radius of the circle, drop a perpendicular from the centre of the circle to any side of the triangle. Using the circle and the radius the escribed circle can be drawn.

Advice to Teachers

Teachers are advised to emphasize determination of the radius of the ***escribed*** or ***inscribed circle*** by dropping a perpendicular from the centre to a side of the circle. Teachers should discourage students from the use of trial and error methods.

Question 6

A student at a certain college has a 60% chance of passing an examination at the first attempt. Each time a student fails and repeats the examination, his chances of passing are increased by 15%.

Calculate the probability that a student in the college passes an examination at the second or at the third attempt.

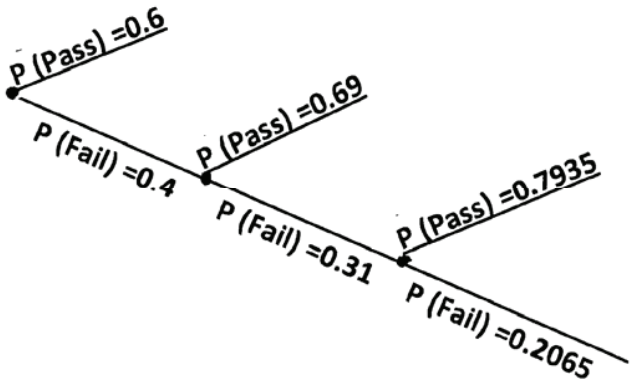
This question tested candidates' knowledge on the concept of probability. Candidates were required to interpret percentage (%) chance as probability. The use of a probability tree and then computation of the various probabilities along the branches was the most helpful approach to the question.

Weaknesses

Most candidates who were unable to answer the question added the given percentage instead of working out percentage increase.

Expected Responses

Candidates needed to use the following tree diagram to answer the question.



The probability of passing in the second attempt

$$= 0.4x0.69$$

The probability of passing in the second or third attempt

$$= 0.4x0.69 + 0.4x0.31x0.7935$$
$$= 0.276 + 0.098394$$
$$= 0.374394$$

Advice to Teachers

Teachers are advised to emphasize that probability does not exceed 1 at any time. Students should appreciate that any process that purports to create a probability greater than 1 is wrong.

Question 12

Solve for y in the equation $\log_{10}(3y + 2) - 1 = \log_{10}(y - 4)$.

This question tested candidates' knowledge on laws of logarithms.

Weaknesses

Majority of the candidates could not interpret 1 as $\log_{10} 10$. All terms in a logarithm equation are logs and plain numbers must be interpreted as logs.

Expected Responses

Candidates were required to interpret 1 as $\log_{10} 10$ and then apply logarithm laws of multiplication and division.

$$\log_{10} 10 = 1$$

$$\therefore \log \frac{(3y+2)}{10} = \log_{10}(y-4)$$

$$\frac{3y+2}{10} = y-4$$

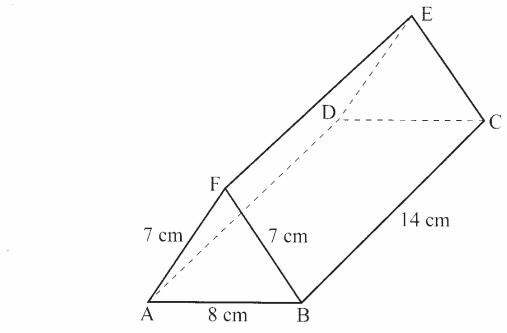
$$y = 6$$

Advice to Teachers

Teachers need to explain the concept behind dropping of logs. It is important to note that some candidates literally divide log by the word 'log'; it is not cancellation but dropping.

Question 14

The figure below represents a triangular prism. The faces ABCD, ADEF and CBFE are rectangles. AB = 8 cm, BC = 14 cm, BF = 7 cm and AF = 7 cm.



Calculate the angle between faces BCEF and ABCD.

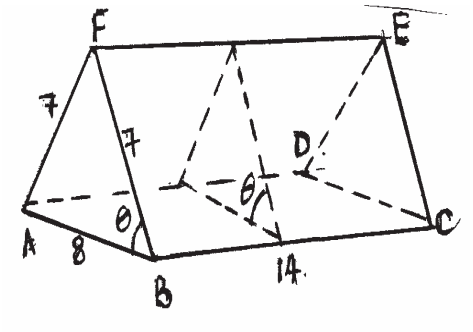
This question tested the candidates' ability to apply this knowledge on trigonometric ratio to work out angles in 3-dimensional geometry.

Weaknesses

Majority of the candidates were not able to identify the appropriate angle that defines the angle between planes BCEF and ABCD.

Expected Responses

Candidates were required to find an angle between two intersecting planes. To do this, the candidates needed to identify the required angle (θ) as indicated below:



$$Cos\theta = \frac{4}{7} \Rightarrow \theta = 55.1500954° \approx 55.15$$

Advice to Teachers

Teachers must insist on identifying the angle between two planes by lines on each plane meeting at a point on the line of intersection of the planes and those that are perpendicular to the line of intersection.

Question 21

Two policemen were together at a road junction. Each had a *walkie talkie*. The maximum distance at which one could communicate with the other was 2.5 km.

One of the policemen walked due East at 3.2 km/h while the other walked due North at 2.4 km/h.

The policeman who headed East travelled for x km while the one who headed North travelled for y km before they were unable to communicate.

(a) Draw a sketch to represent the relative positions of the policemen.

(b) (i) From the information above form two simultaneous equations in x and y.

(ii) Find the values of x and y.

(iii) Calculate the time taken before the policemen were unable to communicate.

This question tested candidates' ability to apply their knowledge of formation and solution of quadratic equations on everyday life situations.

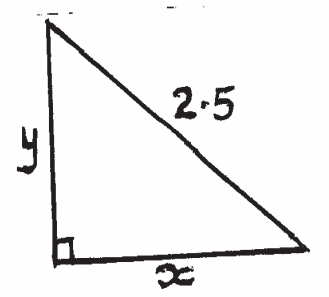
Weaknesses

Most candidates were not able to conceptualize the movements of the two policemen and hence were unable to sketch the movements.

Expected Responses

Candidates were required to form and solve linear and quadratic equations from given information. Candidates needed to interpret the given information into a sketch as shown below:

(a)



(b) The expected equations are:

(i)

$$x^2 + y^2 = 2.5^2$$

$$\frac{y}{2.4} = \frac{x}{3.2}$$

$$y = \frac{3x}{4}$$

$$\Rightarrow x^2 + (\frac{3}{4}x)^2 = 2.5^2$$

(ii) $$16x^2 + 9x^2 = 6.25x16$$

$$x^2 = \frac{6.25x16}{25}$$

$$x = 2km$$

$$y = 1.5km$$

(iii) Hence, time taken before the policemen were unable to communicate

$$= \frac{2}{3.2} or \frac{1.5}{2.4} = 0.625hrs$$

Advice to Teachers

Teaching should be done with straight lines using rulers and all necessary information provided to students.

Question 23

Halima deposited Ksh 109 375 in a financial institution which paid simple interest at the rate of 8% p.a. At the end of 2 years, she withdrew all the money. She then invested the money in shares. The value of the shares depreciated at 4% p.a. during the first year of investment. In the next 3 years, the value of the shares appreciated at the rate of 6% every four months.

(a) Calculate the amount Halima invested in shares.

(b) Calculate the value of Halima's shares:

(i) at the end of the first year;

(ii) at the end of the fourth year, to the nearest shilling.

(c) Calculate Halima's gain from the shares as a percentage.

This question tested candidates' knowledge on investment skills. Knowledge of commercial arithmetic dealing with

simple interest, depression and appreciation were required to answer the question.

Weaknesses

The major challenge to candidates in this question was the choice of number of figures in rounding off to the nearest shilling where 0.5 was either dropped or enhanced.

Expected Responses

(a) Candidates were required to workout the interest accrued after Halima deposited Kshs 109,375.

$$\text{Interest} = 109375x\frac{8}{100}x2 = 17500$$

Then the amount Halima invested in shares is calculated:

$$\text{Amount} = 109375 + 17500 = Shs126875$$

(b) Candidates were required to calculate the value of Halima's shares at the end of the first year and at the end of the fourth year as follows:

(i) First year value of shares

$$= \frac{96}{100}x126875 = Ksh121800$$

(ii) Fourth year value of shares

$$= 121800(1 + \frac{6}{100})^9 = Ksh205779$$

(c) Candidates were required to calculate Halima's gain from the shares as a percentage as follows:

$$\%gain = \frac{205779 - 126875}{126875}x100\%$$

$$= 62.19\%$$

Advice to Teachers

Teachers are advised to explain to students on how to determine the value of ***n*** as used in the compound interest formula where compounding is not annual.

5.4 GENERAL COMMENTS

5.4.1 Teachers should endeavour to cover the syllabus early enough to enable ample time for comprehensive revision. Candidates on their part should read and adhere to the instructions demanded on the front page of the examination paper.

5.4.2 Teachers should encourage candidates to attempt all the required questions; they should avoid leaving too many blanks.

5.4.3 As evidenced in this report, a number of questions that required the application of construction skills were considered for analysis. This is an indication that candidates are ill prepared to answer questions on this concept. Teachers are therefore required to ensure that students are taken through in detail and more

exercises are given for practice.