3.0 PART ONE: ANALYSIS OF DIFFICULT QUESTIONS

3.1 MATHEMATICS ALT A (121)

In the year 2012 Mathematics Alternative A was tested in two papers. **Paper 1 (121/1)** and **Paper 2 (121/2)**. Each paper consisted of two sections: Section 1 (50 marks) compulsory short answer questions of not more than four marks each and Section II (50 marks), a choice of 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 2012 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 8: Candidates' Performance in Mathematics Alt A for the last five years 2008 – 2012

Year	Paper	Candidature	Maximum Score	Mean Score	Standard Deviation
2008	1		100	22.76	22.76
	2	**304908**	100	19.82	19.56
	Overall		**200**	**42.59**	**41.53**
2009	1		100	22.37	19.71
	2	**335615**	100	19.89	18.78
	Overall		**200**	**42.26**	**37.65**
2010	1		100	26.21	20.63
	2	**356072**	100	19.92	20.35
	Overall		**200**	**46.07**	**40.02**
2011	1		100	21.36	21.66
	2	**409887**	100	28.22	23.57
	Overall		**200**	**49.57**	**44.30**
2012	**1**		100	29.46	23.98
	2	**433017**	100	27.86	23.18
	Overall		**200**	**57.31**	**46.20**

From the table the following observations can be made:

3.1.1 The overall performance shows an increasing trend in the mean. This is an improvement compared to the previous years.

3.1.2 There is a notable improvement in the performance of Paper 1 (121/1) from a mean of 21.36 in the year 2011 to a mean of 29.46 in the year 2012. However, Paper 2 (121/2) recorded a slight decline.

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 comments from the chief examiners reports and an analysis the students' responses and scores in the questions. The analysis was done using scripts that were purposively sampled.

3.1.2 Mathematics Paper 1 (121/1)

In this paper question one in section I was the best performed as seen from the analysis of a sample of scripts. In section II, questions 17 and 18 were very popular among the candidates whereas questions 20 and 22 were unpopular.
Questions 2, 5, 7, 16, 21, 22 and 23 were performed poorly, these question are discussed below.

Question 2

Find the reciprocal of 0.216 correct to 3 decimal places, hence evaluate

$$\frac{\sqrt[3]{0.512}}{0.216}$$ (3 marks)

Weaknesses

Most candidates were able to obtain the reciprocal but were unable to use it in evaluation of the given problem. They divided $\sqrt[3]{0.512}$ with the reciprocal of 0.216, instead of multiplying.

Expected response

$$\frac{1}{0.216} = 4.630$$

$$\frac{\sqrt[3]{0.512}}{0.216} = 0.8 \times 4.630$$

$$= 3.704$$

Advice to teachers

Explanation on the use of hence and meaning of reciprocal should be emphasized.

Question 5

Given that $9^{2y} \times 2^{x} = 72$, find the values of x and y. (3 marks)

Weaknesses

Candidates were unable to express 72 into powers of its prime factors and inability to compare the powers of these factors.

Expected response

$9^{2y} \times 2^x = 9 \times 8$

$(3^2)^{2y} \times 2^x = 3^2 \times 2^3$

$(3^2)^{2y} = 3$ and $2^x = 2^3$

$4y = 2$ and $x = 3$

$y = \frac{1}{2}$ and $x = 3$

Advice to teachers

There is need to teach factorization of numbers expansively.

Question 7

Koech left home to a shopping centre 12 km away, running at 8 km/h. Fifteen minutes later, Mutua left the same home and cycled to the shopping centre at 20 km/h. Calculate the distance to the shopping centre at which Mutua caught up with Koech. (3 marks)

Weaknesses

Most candidates could not form linear equations from the given situation.

Expected response

$\frac{x}{8} = \frac{x}{20} + \frac{1}{4}$

$\frac{x}{8} - \frac{x}{20} = \frac{1}{4}$

$\Rightarrow \frac{3x}{40} = \frac{1}{4}$

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

Distance to shopping centre

$12 - 3\frac{1}{3} = 8\frac{2}{3}$ km

Advice to teachers

Formation and solution of linear equations should be emphasized.

Question 16

Bukra had two bags A and B, containing sugar. If he removed 2 kg of sugar from bag A and added it to bag B, the mass of sugar in bag B would be four times the mass of the sugar in bag A. If he added 10 kg of sugar to the original amount of sugar in each bag, the mass of sugar in bag B would be twice the mass of the sugar in bag A. Calculate the original mass of sugar in each bag. (3 marks)

Weaknesses

Most candidates could not form equations from the given situation.

Expected response

$$4(A-2)=B+2$$
$$2(A+10)=B+10$$

$$4A-B=10....(i)$$
$$\mp 2A \pm B = \pm 10...(ii)$$
$$2A=20$$
$$\Longrightarrow A=10$$

Substitute A = 10 in (i)

$$4\times 10-B=10$$
$$\Longrightarrow B=30$$

Advice to teachers

Emphasize more on application of simultaneous equations to real life situations.

Question 21

The vertices of quadrilateral OPQR are O(0, 0), P(2, 0), Q(4, 2) and R(0, 3). The vertices of its image under a rotation are O'(1, −1), P'(1, −3), Q'(3, −5) and R'(4, −1).

(a) (i) On the grid provided, draw OPQR and its image O'P'Q'R'. (2 marks)

(ii) By construction, determine the centre and angle of rotation. (3 marks)

(b) On the same grid as (a)(i) above, draw O"P"Q"R", the image of O'P'Q'R' under a reflection in the line $y = x$. (2 marks)

(c) From the quadrilaterals drawn, state the pairs that are:

(i) directly congruent; (1 mark)

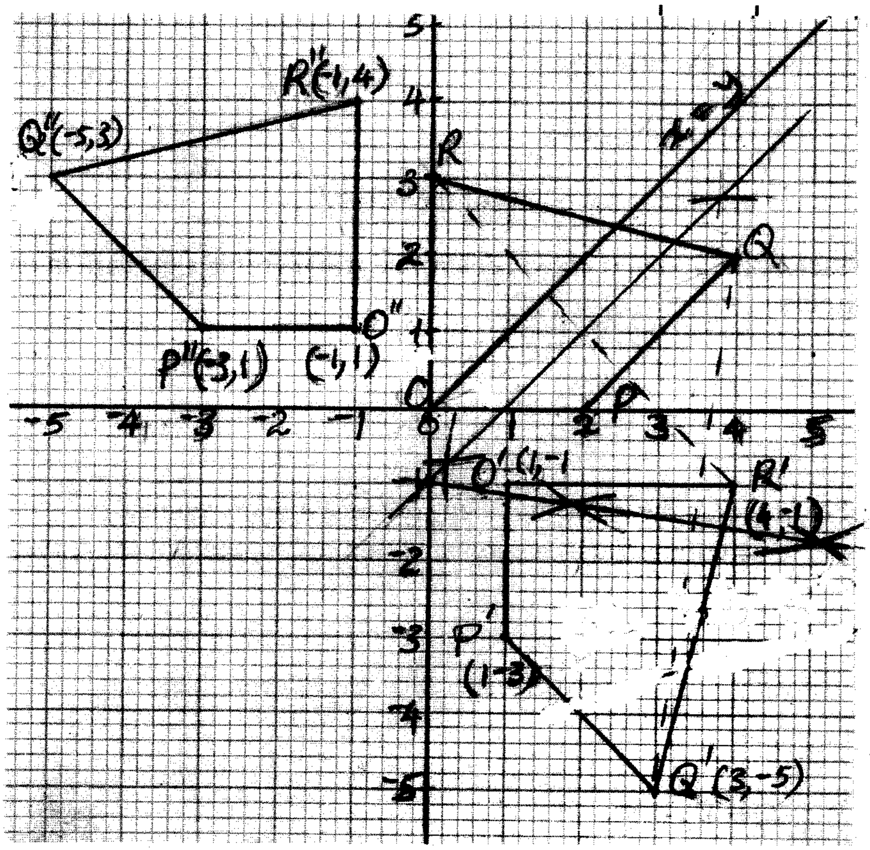
(ii) oppositely congruent. (2 marks)

Weaknesses

Candidates were not able to locate the centre and angle of rotation. Not able to identify the congruency.

Expected response

(a)(i)



(a)(ii)

centre of rotation (0, -1)

angle of rotation - 90^0

c) (i) directly congruent quads:

OPQR and O'P'Q'R'

(ii) Oppositely congruent quads.:

OPQR and O"P"Q"R"

O'P'Q'R' and O"P"Q"R"

Advice to teachers

Teach thoroughly on location of centre, angle of rotation and on congruency.

Question 22

The equation of a curve is $y = 2x^3 + 3x^2$.

(a) Find:

(i) the x - intercept of the curve; (2 marks)

(ii) the y - intercept of the curve. (1 mark)

(b) (i) Determine the stationery points of the curve. (3 marks)

(ii) For each point in (b) (i) above, determine whether it is a maximum or a minimum. (2 marks)

(c) Sketch the curve. (2 marks)

Weaknesses

Candidates were unable to sketch the curve and identify the stationary points.
They were also not able to determine the maximum and minimum points of the curve.

Expected response

(a) (i) x - intercepts

when y= 0

$x^2(2x+3)=0$

$x = 0 \; and \; x = -\frac{3}{2}$

(ii) y - intercept

when x = 0, y = 0

(b) (i) stationary points of curve

$\frac{dy}{dx} = 6x^2 + 6x$

stationery points when $\frac{dy}{dx} = 0$

i.e. $6x^2 + 6x = 0$

$6x(x+1) = 0$

$x = 0 \; or \; x = -1$

$\therefore$ stationary points are:

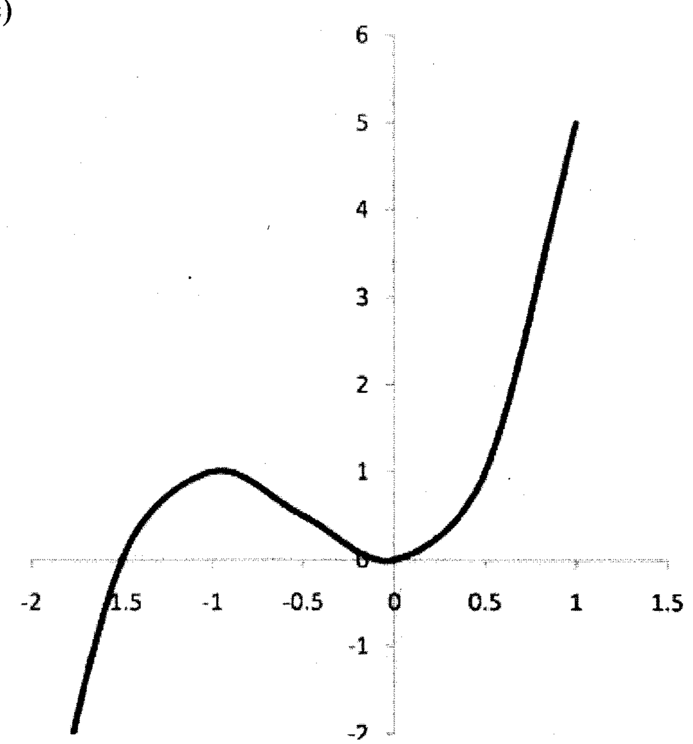
$(0,0)$ and $(-1,1)$

(ii)

x	-2	$-1\frac{1}{2}$	-1	$-\frac{1}{2}$	0	$\frac{1}{2}$	1
$\frac{dy}{dx}$	12	$4\frac{1}{2}$	0	$-1\frac{1}{2}$	0	$4\frac{1}{2}$	12

minimum point (0,0)
maximum point (-1,1)

(c)



Advice to teachers

There is need to teach calculus and its applications thoroughly.

Question 23

Three pegs R, S and T are on the vertices of a triangular plain field. R is 300 m from S on a bearing of 300° and T is 450 m directly south of R.

(a) Using a scale of 1 cm to represent 60 m, draw a diagram to show the positions of the pegs. (3 marks)

(b) Use the scale drawing to determine:

(i) the distance between T and S in metres; (2 marks)

(ii) the bearing of T from S. (1 mark)

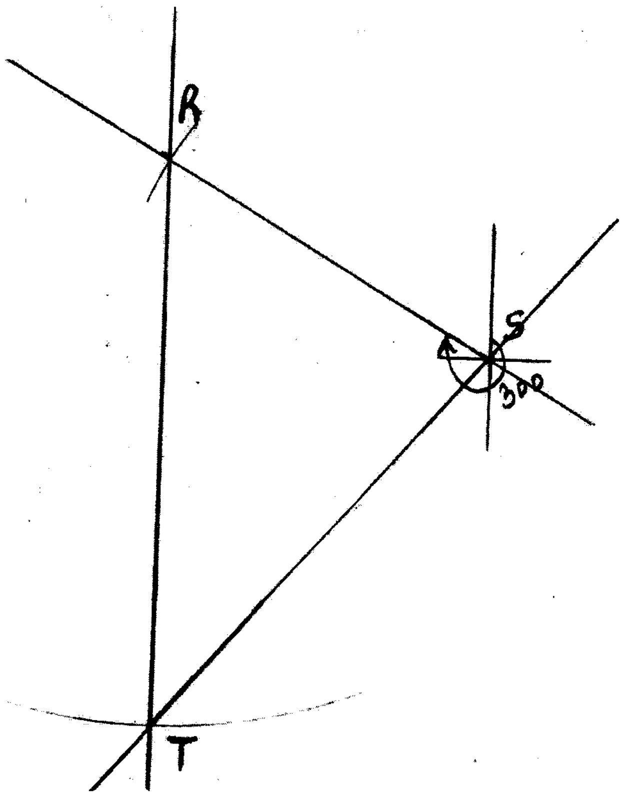
(c) Find the area of the field, in hectares, correct to one decimal place. (4 marks)

Weaknesses

Many candidates were unable to draw the scale drawing accurately. Some candidates were unable to convert the metres squared to hectares.

Expected response

(a)



(b) (i) Distance TS = 6.6cm (±0.1cm)

= 396m

(ii) Bearing of T from S = 221^0

(c) Area of field

$\angle TRS = 60°$

$area = \frac{1}{2} \times 300 \times 450 \sin 60°$

$= \frac{58456.71476}{10000}$

=5.8 ha

Advice to teachers

Emphasize on how to make accurate scale drawing and bearings and conversion of metres squared to hectares.

3.1.3 Mathematics Paper 2 (121/2)

In this paper question 2 in section I was the best performed as seen from the analysis of a sample of scripts. In section II, questions 18, 19 and 20 were very popular among the candidates whereas questions 17 and 21 were unpopular.

Questions 1, 7, 8, 12, 17 and 21 were performed poorly, these question are discussed below.

Question 1

Evaluate $\dfrac{\log 4^5 - \log 5^4}{\log 4^{\frac{1}{5}} + \log 5^{\frac{1}{4}}}$, giving the answer to 4 significant figures. (2 marks)

Weaknesses

Many candidates were unable to use the laws of logarithm to evaluate.

Expected response

$$\frac{5\log 4 - 4\log 5}{\frac{1}{5}\log 4 + \frac{1}{4}\log 5}$$

$$= \frac{3.010299957 - 2.795880017}{0.120411998 + 0.174742501}$$

$$= 0.726466785$$

$$\simeq 07265 \qquad \text{(4 s.f.)}$$

Advice to teachers

Give more practice on use of laws of logarithms.

Question 7

Kago deposited Ksh 30 000 in a financial institution that paid simple interest at the rate of 12% per annum. Nekesa deposited the same amount of money as Kago in another financial institution that paid compound interest. After 5 years, they had equal amounts of money in the financial institutions.
Determine the compound interest rate per annum, to 1 decimal place, for Nekesa's deposit.
(4 marks)

Weaknesses

Relating the accumulated amounts in simple interest and the one in compound interest was a problem to most candidates. Some could also not obtain the fifth root.

Expected response

Amount for Kago

$$= 30000 + \frac{12}{100} \times 30000 \times 5$$

$$= 48000$$

Compound interest rate for Nekesa

$$30000\left(1 + \frac{r}{100}\right)^5 = 48000$$

$$\left(1 + \frac{r}{100}\right)^5 = \frac{48000}{30000} = 1.6$$

$$1 + \frac{r}{100} = \sqrt[5]{1.6}$$

$$r = 100(1.098560543 - 1)$$

$$= 9.9\%$$

Advice to teachers

Give more questions in application of commercial arithmetic.

Question 8

The masses in kilograms of 20 bags of maize were; 90, 94, 96, 98, 99, 102, 105, 91, 102, 99, 105, 94, 99, 90, 94, 99, 98, 96, 102 and 105.
Using an assumed mean of 96 kg, calculate the mean mass, per bag, of the maize. (3 marks)

Weaknesses

Most candidates could not compute the mean deviations hence unable to do the question.

Expected response

Differences from assumed mean

$$-6 - 2 + 0 + 2 + 3 + 6 + 9 - 5 + 6 + 3 + 9$$
$$-2 + 3 - 6 - 2 + 3 + 2 + 0 + 6 + 9 = 38$$

$$\therefore mean = 96 + \frac{38}{20}$$

$$= 97.9$$

Advice to teachers

Give more practice in statistical questions.

Question 12

(a) Expand $(1 + x)^7$ up to the 4th term. (1 mark)

(b) Use the expansion in part (a) above to find the approximate value of $(0.94)^7$. (2 marks)

Weaknesses

Most candidates could not obtain the coefficients of the expansion.

Expected response

(a)

$$(1 + x)^7 = 1^7 + 7 \times 1^6 \times x + 21 \times 1^5 \times x^2 + 35 \times 1^4 \times x^3 + \ldots$$

$$= 1 + 7x + 21x^2 + 35x^3$$

(b)

$$(0.94)^7 = [1 + (-0.06)]^7$$

$$= 1 + 7 \times (-0.06) + 21 \times (-0.06)^2 + 35 \times (-0.06)^3$$

$$= 1 - 0.42 + 0.0756 - 0.00756$$

$$= 0.64804$$

Advice to teachers

Teach binomial expansion and its applications thoroughly.

Question 17

Amaya was paid an initial salary of Ksh 180 000 per annum with a fixed annual increment. Bundi was paid an initial salary of Ksh 150 000 per annum with a 10% increment compounded annually.

(a) Given that Amaya's annual salary in the 11th year was Ksh 288 000, determine:

(i) his annual increment; (2 marks)

(ii) the total amount of money Amaya earned during the 11 years. (2 marks)

(b) Determine Bundi's monthly earnings, correct to the nearest shilling, during the eleventh year. (2 marks)

(c) Determine, correct to the nearest shilling:

(i) the total amount of money Bundi earned during the 11 years. (2 marks)

(ii) The difference between Bundi's and Amaya's average monthly earnings during the 11 years. (2 marks)

Weaknesses

The question was unpopular and those who attempted it could not solve correctly.

Expected response

(a) (i)

$$180000 + (11 - 1)x = 288000$$
$$10x = 108000$$
$$x = 10800$$

(a) (ii)

$$S_{11} = \frac{11}{2}(180000 + 288000)$$
$$= 2574000$$

(b)

$$\frac{150000 \times 1.1^{10}}{12}$$
$$= 32422$$

(c) (i)

$$\frac{[150000 \times (1.1^{11} - 1)]}{(1.1 - 1)}$$
$$= 2779675$$

(c) (ii) Difference between monthly averages for the 11 years

$$\frac{2779675 - 2574000}{11 \times 12}$$
$$= 1558$$

Advice to teachers

Give more exercises on application of A.P and G.P.

Question 21

(a) On the same diagram construct:

(i) triangle ABC such that AB $= 9$ cm, AC $= 7$ cm and angle CAB $= 60°$; (2 marks)

(ii) the locus of a point P such that P is equidistant from A and B; (1 mark)

(iii) the locus of a point Q such that CQ ≤ 3.5 cm. (1 mark)

(b) On the diagram in part (a):

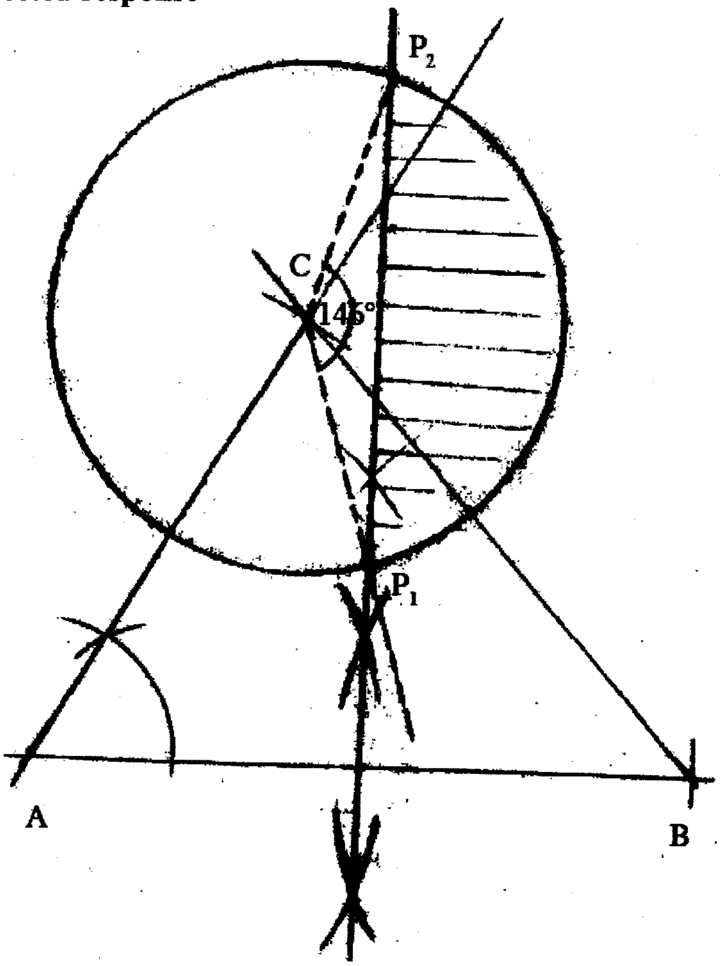
(i) shade the region R, containing all the points enclosed by the locus of P and the locus of Q, such that AP $\geq$ BP; (2 marks)

(ii) find the area of the region shaded in part (b)(i) above. (4 marks)

Weaknesses

Most candidates could not represent the required loci.

Expected response



(ii) area of shaded region

area of minor sector P_1CP_2

$= \frac{146}{360} \times \pi \times 3.5^2$

$\simeq 15.6\ cm^2$

area of ΔP_1CP_2

$\frac{1}{2} \times 3.5^2 \sin 146°$

$\simeq 3.4\ cm^2$

$\therefore$ shaded area

15.6 - 3.4

=12.2 cm^2

Advice to teachers

Give more practice and exercises on loci.

4.0 PART TWO: THE YEAR 2012 KCSE EXAMINATION QUESTION PAPERS

4.1 MATHEMATICS (121 AND 122)

4.1.1 Mathematics Alt.A Paper 1 (121/1)

SECTION I (50 marks)

*Answer **all** the questions in this section in the spaces provided.*

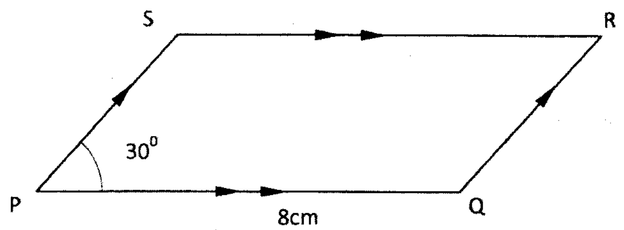
1 Without using a calculator, evaluate $\dfrac{1\frac{1}{5}-1\frac{1}{3}}{\frac{1}{8}-(-\frac{1}{2})^2} - \frac{7}{15}$ of 2. (4 marks)

2. Find the reciprocal of 0.216 correct to 3 decimal places, hence evaluate (3 marks)

$$\frac{\sqrt[3]{0.512}}{0.216}.$$

3 Expand and simplify the expression $(2x^2 - 3y^3)^2 + 12x^2y^3$ (2 marks)

4 In the parallelogram PQRS shown below, PQ = 8cm and angle SPQ = 30°.



If the area of the parallelogram is 24 cm^3, find its perimeter. (3 marks)

5 Given that $9^{2y} \times 2^x = 72$, find the values of x and y. (3 marks)

6 Three bells ring at intervals of 9 minutes, 15 minutes and 21 minutes. The bells will next ring together at 11.00 pm. Find the time the bells had last rang together. (3 marks)

7 Koech left home to a shopping centre 12km away, running at 8km/h. Fifteen minutes later, Mutua left the same home and cycled to the shopping centre at 20km/h. Calculate the distance to the shopping centre at which Mutua caught up with Koech. (3 marks)

8 Using a pair of compasses and ruler only, construct a quadrilateral ABCD in which AB = 4cm, BC = 6cm, AD = 3cm, angle ABC = 135° and angle DAB = 60°. Measure the size of angle BCD. (4 marks)

9 Given that **OA** = 2**i** + 3**j** and **OB** = 3**i** – 2**j**
Find the magnitude of **AB** to one decimal place. (3 marks)

10 Given that $\tan x^\circ = \frac{3}{7}$, find $\cos (90 - x)^\circ$ giving the answer to 4 significant figures. (2 marks)

11 Given that $\mathbf{A} = \begin{pmatrix} 1 & 0 \\ -2 & 3 \end{pmatrix}$, $\mathbf{B} = \begin{pmatrix} 3 & 0 \\ 2 & 1 \end{pmatrix}$ and $\mathbf{C} = 2\mathbf{AB} - \mathbf{A}^2$. Determine matrix $\mathbf{C}$. (4 marks)

12 Without using mathematical tables or a calculator, solve the equation
$2\log_{10}x - 3\log_{10}2 + \log_{10}32 = 2$. (3 marks)

13 A line L passes through point (3,1) and is perpendicular to the line $2y = 4x + 5$. Determine the equation of line L. (3 marks)

14 A Forex Bureau in Kenya buys and sells foreign currencies as shown below:

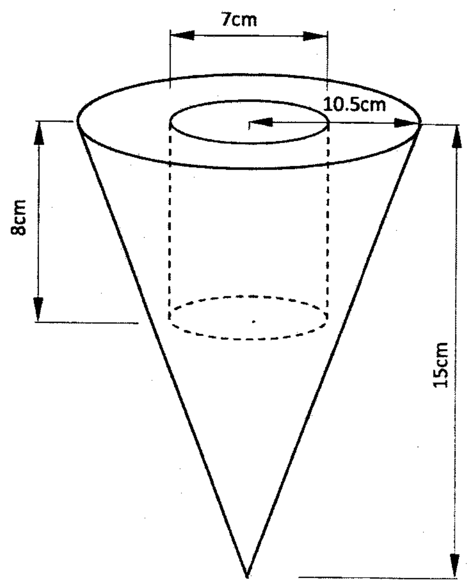
Currency	Buying (Ksh)	Selling (Ksh)
Chinese Yuan	12.34	12.38
South African Rand	11.28	11.37

A businesswoman from China converted 195 250 Chinese Yuan into Kenya shillings.

(a) Calculate the amount of money, in Kenya shillings, that she received. (1 mark)

(b) While in Kenya, the businesswoman spent Ksh 1 258 000 and then converted the balance into South African Rand. Calculate the amount of money, to the nearest Rand, that she received. (3 marks)

15 The figure below represents a solid cone with a cylindrical hole drilled into it. The radius of the cone is 10.5 cm and its vertical height is 15 cm. The hole has a diameter of 7 cm and depth of 8 cm.



Calculate the volume of the solid. (3 marks)

16 Bukra had two bags A and B, containing sugar. If he removed 2kg of sugar from bag A and added it to bag B, the mass of sugar in bag B would be four times the mass of the sugar in bag A. If he added 10kg of sugar to the original amount of sugar in each bag, the mass of sugar in bag B would be twice the mass of the sugar in bag A. Calculate the original mass of sugar in each bag. (3 marks)

SECTION II (50 marks)

Answer only ***five*** *questions in this section in the spaces provided.*

17 The table below shows the height, measured to the nearest cm, of 101 pawpaw trees.

Height in cm.	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59
Frequency	2	15	18	25	30	6	3	2

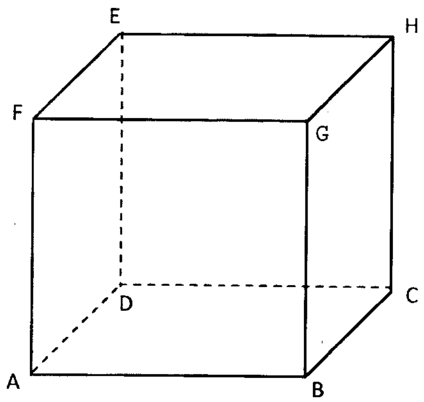
(a) State the modal class. (1 mark)

(b) Calculate to 2 decimal places:

(i) the mean height; (4 marks)

(ii) the difference between the median height and the mean height. (5 marks)

18 The figure below represents a solid cuboid ABCDEFGH with a rectangular base. AC = 13cm, BC = 5cm and CH = 15cm.



(a) Determine the length of AB. (1 mark)

(b) Calculate the surface area of the cuboid. (3 marks)

(c) Given that the density of the material used to make the cuboid is $7.6 g/cm^3$, calculate its mass in kilograms. (4 marks)

(d) Determine the number of such cuboids that can fit exactly in a container measuring 1.5m by 1.2m by 1m. (2 marks)

19 Two alloys, A and B, are each made up of copper, zinc and tin. In alloy A, the ratio of copper to zinc is 3:2 and the ratio of zinc to tin is 3:5.

(a) Determine the ratio, copper: zinc: tin, in alloy A. (2 marks)

(b) The mass of alloy A is 250kg. Alloy B has the same mass as alloy A but the amount of copper is 30% less than that of alloy A.

Calculate:

(i) the mass of tin in alloy A; (2 marks)

(ii) the total mass of zinc and tin in alloy B; (3 marks)

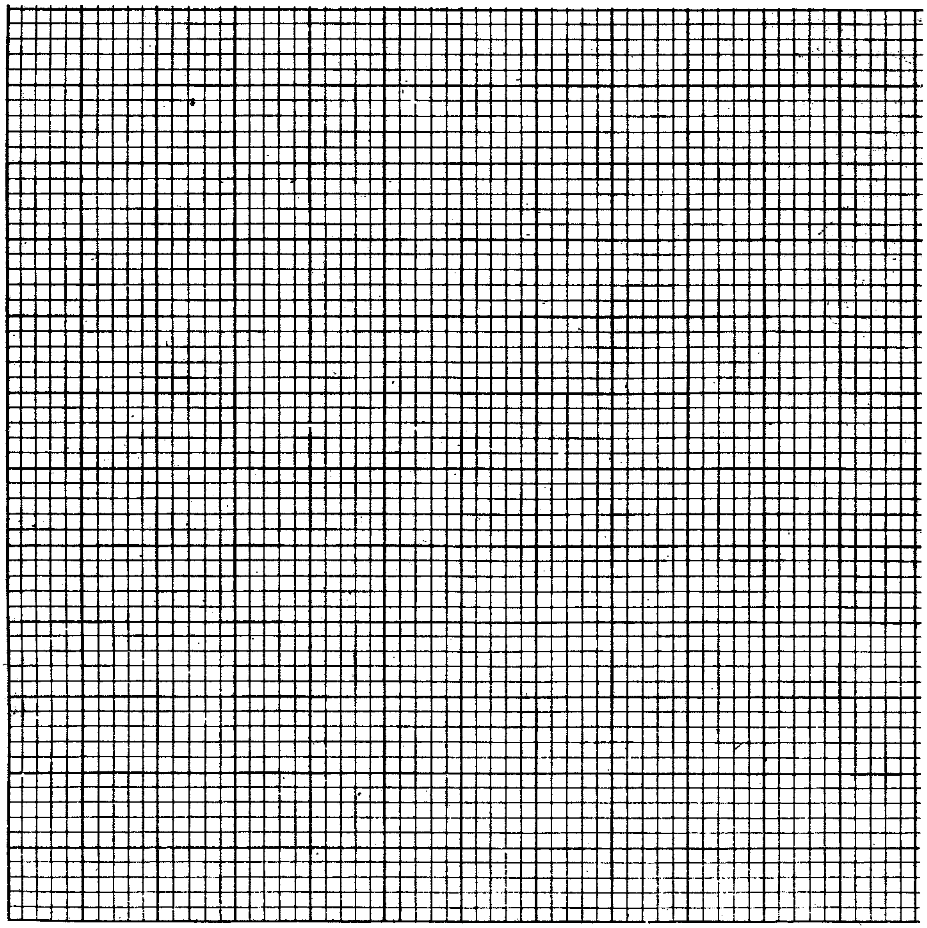
(c) Given that the ratio of zinc to tin in alloy B is 3:8, determine the amount of tin in alloy B than in alloy A. (3 marks)

20 (a) Express $\frac{1}{x-2} - \frac{2}{x+5} = \frac{3}{x+1}$ in the form $ax^2 + bx + c = 0$, where a, b and c are constants hence solve for x. (4 marks)

(b) Neema did y tests and scored a total of 120 marks. She did two more tests which she scored 14 and 13 marks. The mean score of the first y tests was 3 marks more than the mean score for all the tests she did. Find the total number of tests that she did. (6 marks)

21 The vertices of quadrilateral OPQR are O(0, 0), P(2, 0), Q(4, 2) and R(0, 3).
The vertices of its image under a rotation are O'(1, -1), P'(1, -3), Q'(3, -5) and R'(4, -1).

(a) (i) On the grid provided, draw OPQR and its image O'P'Q'R'. (2 marks)



(ii) By construction, determine the centre and angle of rotation. (3 marks)

(b) On the same grid as (a)(i) above, draw O"P"Q"R", the image of O'P'Q'R' under a reflection in the line $y = x$. (2 marks)

(c) From the quadrilaterals drawn, state the pairs that are:

(i) directly congruent; (1 mark)
(ii) oppositely congruent. (2 marks)

22 The equation of a curve is $y = 2x^3 + 3x^2$.

(a) Find :

(i) the x - intercept of the curve; (2 marks)

(ii) the y - intercept of the curve. (1 mark)

(b) (i) Determine the stationery points of the curve. (3 marks)

(ii) For each point in (b) (i) above, determine whether it is a maximum or a minimum. (2 marks)

(c) Sketch the curve. (2 marks)

23 Three pegs R, S and T are on the vertices of a triangular plain field. R is 300m from S on a bearing of 300° and T is 450m directly south of R.

(a) Using a scale of 1cm to represent 60m, draw a diagram to show the positions of the pegs. (3 marks)

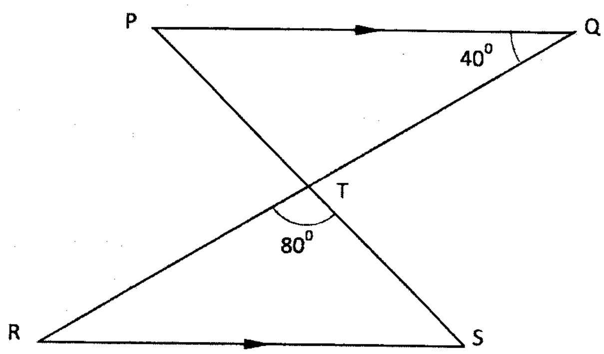
(b) Use the scale drawing to determine:

(i) the distance between T and S in metres; (2 marks)

(ii) the bearing of T from S. (1 mark)

(c) Find the area of the field, in hectares, correct to one decimal place. (4 marks)

24 In the figure below, PQ is parallel to RS. The lines PS and RQ intersect at T. RQ = 10cm, RT:TQ = 3:2, angle PQT = 40° and angle RTS = 80°.



(a) Find the length of RT. (2 marks)

(b) Determine, correct to 2 significant figures:

(i) the perpendicular distance between PQ and RS; (2 marks)

(ii) the length of TS. (2 marks)

(c) Using the cosine rule, find the length of RS correct to 2 significant figures. (2 marks)

(d) Calculate, correct to one decimal place, the area of triangle RST. (2 marks)

4.1.2 Mathematics Alt. A Paper 2 (121/2)

SECTION 1 (50 marks)

*Answer **all** the questions in this section in the spaces provided.*

1 Evaluate $\dfrac{\log 4^5 - \log 5^4}{\log 4^{\frac{1}{5}} + \log 5^{\frac{1}{4}}}$, giving the answer to 4 significant figures. (2 marks)

2 Make n the subject of the equation. (3 marks)

$$\frac{r}{p} = \frac{m}{\sqrt{n-1}}$$

3 An inlet tap can fill an empty tank in 6 hours. It takes 10 hours to fill the tank when the inlet tap and an outlet tap are both opened at the same time. Calculate the time the outlet tap takes to empty the full tank when the inlet tap is closed. (3 marks)

4 Given that, $\boldsymbol{P} = 2\boldsymbol{i} - 3\boldsymbol{j} + \boldsymbol{k}$, $\boldsymbol{Q} = 3\boldsymbol{i} - 4\boldsymbol{j} - 3\boldsymbol{k}$ and $\boldsymbol{R} = 3\boldsymbol{P} + 2\boldsymbol{Q}$, find the magnitude of R to 2 significant figures. (3 marks)

5 Solve the equation $\text{Sin}(2t + 10)° = 0.5$ for $0° \leq t \leq 180°$ (2 marks)

6 Construct a circle centre x and radius 2.5cm. Construct a tangent from a point P, 6cm from x to touch the circle at R. Measure the length PR. (4 marks)

7 Kago deposited Ksh 30 000 in a financial institution that paid simple interest at the rate of 12% per annum. Nekesa deposited the same amount of money as Kago in another financial institution that paid compound interest. After 5 years, they had equal amounts of money in the financial institutions.
Determine the compound interest rate, to 1 decimal place, for Nekesa's deposit. (4 marks)

8 The masses in kilograms of 20 bags of maize were; 90, 94, 96, 98, 99, 102, 105, 91, 102, 99, 105, 94, 99, 90, 94, 99, 98, 96, 102 and 105.
Using an assumed mean of 96kg, calculate the mean mass, per bag, of the maize. (3 marks)

9 Solve the equations

$$x + y = 17$$

$$xy - 5x = 32$$

(4 marks)

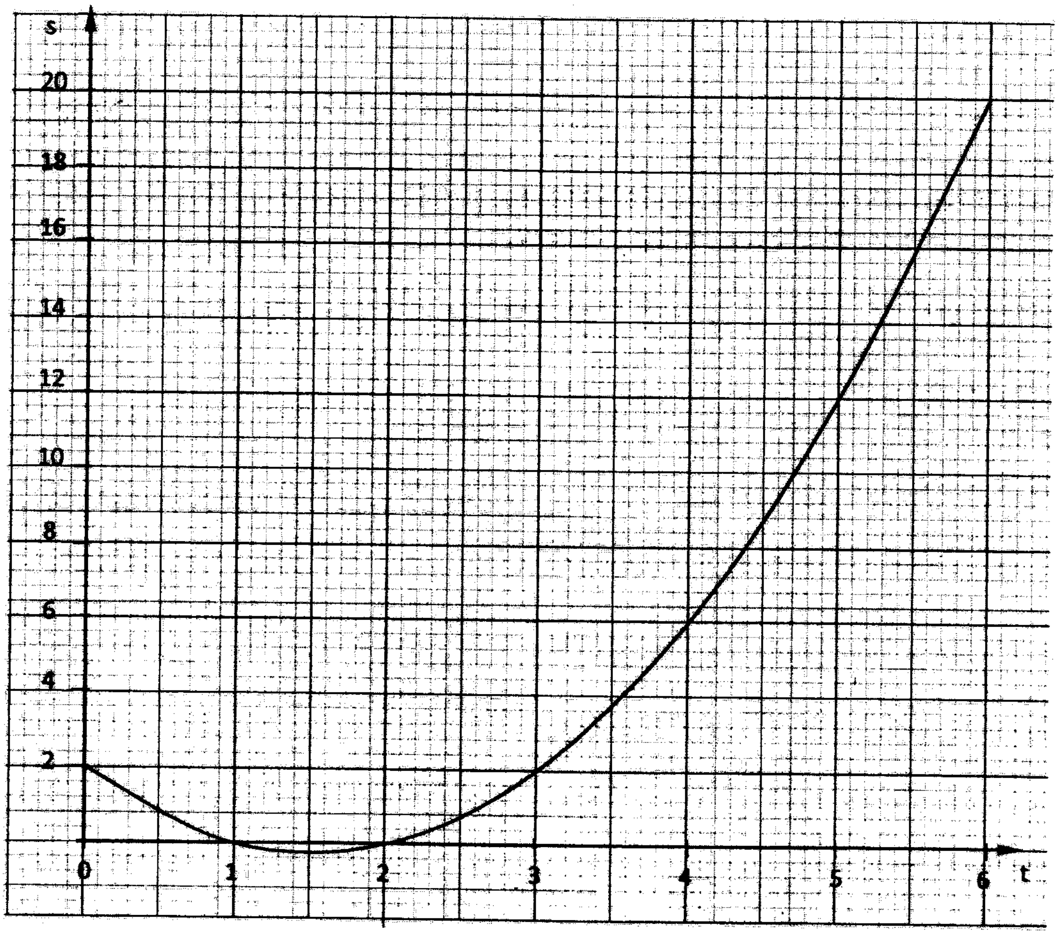
10 Simplify $\dfrac{\sqrt{5}}{\sqrt{5}-2}$, leaving the answer in the form $a + b\sqrt{c}$, where a, b and c are integers. (2 marks)

11 The base and height of a right angled triangle were measured as 6.4cm and 3.5cm respectively. Calculate the maximum absolute error in the area of the triangle. (3 marks)

12 (a) Expand $(1 + x)^7$ upto the 4^{th} term. (1 mark)

(b) Use the expansion in part (a) above to find the approximate value of $(0.94)^7$. (2 marks)

13 The graph below shows the relationship between distance s metres and time t seconds in the interval $0 \le t \le 6$.

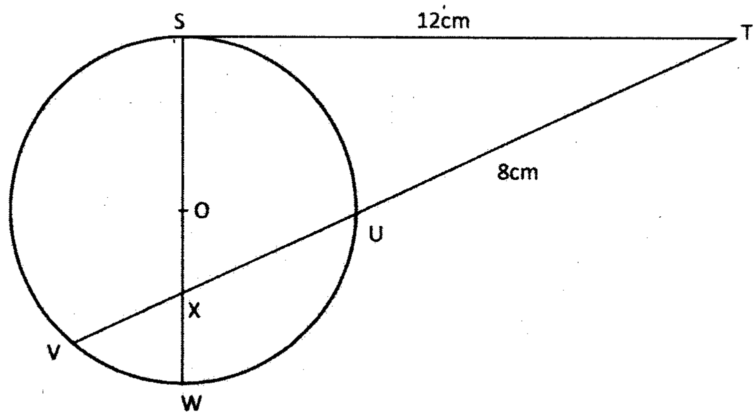


Use the graph to determine:

(a) the average rate of change of distance between t = 3 seconds and t = 6 seconds; (2 marks)

(b) the gradient at t = 3 seconds. (2 marks)

14 In the figure below, the tangent ST meets chord VU produced at T. Chord SW passes through the centre, O, of the circle and intersects chord VU at X. Line ST = 12cm and UT = 8cm.

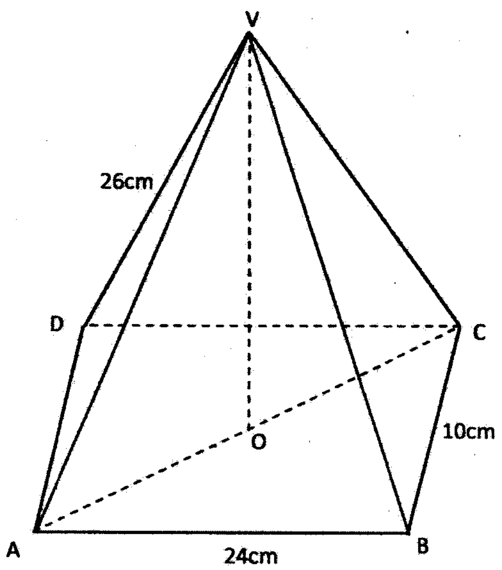


(a) Calculate the length of chord VU. (2 marks)

(b) If WX = 3cm and VX:XU = 2:3, find SX. (2 marks)

15 Three quantities P, Q and R are such that P varies directly as Q and inversely as the square root of R. When P = 8, Q = 10 and R = 16. Determine the equation connecting P, Q and R. (3 marks)

16 In the figure below, VABCD is a right pyramid on a rectangular base. Point O is vertically below the vertex V. AB = 24cm, BC = 10cm and AV = 26cm.



Calculate the angle between the edge AV and the base ABCD. (3 marks)

SECTION II (50 marks)

*Answer only **five** questions in this section in the spaces provided.*

17 Amaya was paid an initial salary of Ksh 180 000 per annum with a fixed annual increment. Bundi was paid an initial salary of Ksh 150 000 per annum with a 10% increment compounded annually.

(a) Given that Amaya's annual salary in the 11th year was Ksh 288 000, determine:

(i) his annual increment; (2 marks)

(ii) the total amount of money Amaya earned during the 11 years. (2 marks)

(b) Determine Bundi's monthly earning, correct to the nearest shilling, during the eleventh year. (2 marks)

(c) Determine, correct to the nearest shilling:

(i) the total amount of money Bundi earned during the 11 years. (2 marks)

(ii) The difference between Bundi's and Amaya's average monthly earnings during the 11 years. (2 marks)

18 OABC is a parallelogram with vertices O(0,0), A(2,0), B(3,2) and C(1,2).

O'A'B'C' is the image of OABC under transformation matrix $\begin{pmatrix} -2 & 0 \\ 0 & -2 \end{pmatrix}$

(a) (i) Find the coordinates of O'A'B'C'. (2 marks)

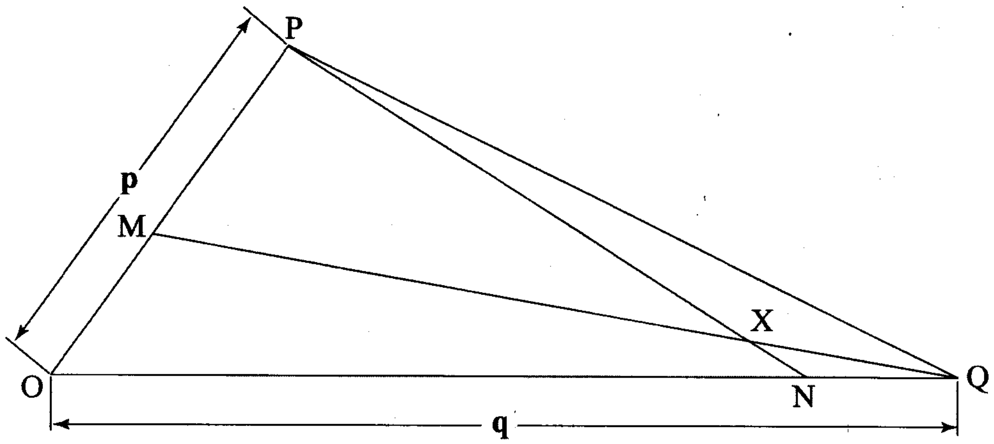
(ii) On the grid provided draw OABC and O'A'B'C'. (2 marks)

(b) (i) Find O″A″ B″ C″, the image of O′ A′ B′ C′ under the transformation matrix $\begin{pmatrix} 1 & 0 \\ 0 & -2 \end{pmatrix}$. (2 marks)

(ii) On the same grid draw O″ A″ B″ C″. (1 mark)

(c) Find the single matrix that maps O″ A″ B″ C″ onto OABC. (3 marks)

19 In triangle OPQ below, **OP** = **p**, **OQ** = **q**. Point M lies on **OP** such that **OM** : **MP** = 2 :3 and point N lies on **OQ** such that **ON** : **NQ** = 5 : 1. Line PN intersects line MQ at X.



(a) Express in terms of **p** and **q**

(i) **PN**; (1 mark)
(ii) **QM**. (1 mark)

(b) Given that **PX** = k**PN** and **QX** = r**QM**, where k and r are scalars:

(i) write two different expressions for **OX** in terms of **p**, **q** and k and r; (2 marks)
(ii) find the values of k and r; (4 marks)
(iii) determine the ratio in which X divides line MQ. (2 marks)

20 In June of a certain year, an employee's basic salary was Ksh 17 000. The employee was also paid a house allowance of Ksh 6 000, a commuter allowance of Ksh 2 500 and a medical allowance of Ksh 1800. In July of that year, the employee's basic salary was raised by 2%.

(a) Calculate the employees:

(i) basic salary for July; (2 marks)
(ii) total taxable income in July of that year. (2 marks)

(b) In that year, the Income Tax Rates were as shown in the table below:

Monthly taxable income (Kshs)	Percentage rate of tax per shilling
Up to 9680	10
From 9881 to 18 800	15
From 18 801 to 27 920	20
From 27 921 to 37 040	25
From 37041 and above	30

Given that the Monthly Personal Relief was Ksh 1056, calculate the net tax paid by the employee. (6 marks)

21 (a) On the same diagram construct:

(i) triangle ABC such that AB = 9cm, AC = 7cm and angle CAB = 60°; (2 marks)

(ii) the locus of a point P such that P is equidistant from A and B; (1 mark)

(iii) the locus of a point Q such that $CQ \leq 3.5$cm. (1 mark)

(b) On the diagram in part (a):

(i) shade the region R, containing all the points enclosed by the locus of P and the locus of Q, such that $AP \geq BP$; (2 marks)

(ii) find the area of the region shaded in part (b)(i) above. (4 marks)

22 A tourist took 1h 20minutes to travel by an aircraft from town T(3°S, 35°E) to town U(9°N, 35°E).
(Take the radius of the earth to be 6370km and $\pi = \frac{22}{7}$),

(a) Find the average speed of the aircraft. (3 marks)

(b) After staying at town U for 30 minutes, the tourist took a second aircraft to town V(9°N, 5°E). The average speed of the second aircraft was 90% that of the first aircraft. Determine the time, to the nearest minute, the aircraft took to travel from U to V. (3 marks)

(c) When the journey started at town T, the local time was 0700h. Find the local time at V when the tourist arrived. (4 marks)

23 A box contains 3 brown, 9 pink and 15 white clothes pegs. The pegs are identical except for the colour.

(a) Find the probability of picking:

(i) a brown peg; (1 mark)

(ii) a pink or a white peg. (2 marks)

(b) Two pegs are picked at random, one at a time, without replacement. Find the probability that:

(i) a white peg and a brown peg are picked; (3 marks)

(ii) both pegs are of the same colour. (4 marks)

24 The acceleration of a body moving along a straight line is $(4 - t)$ m/s^2 and its velocity is v m/s after t seconds.

(a) (i) If the initial velocity of the body is 3m/s, express the velocity v in terms of t. (3 marks)

(ii) Find the velocity of the body after 2 seconds. (2 marks)

(b) Calculate:

(i) the time taken to attain maximum velocity; (2 marks)

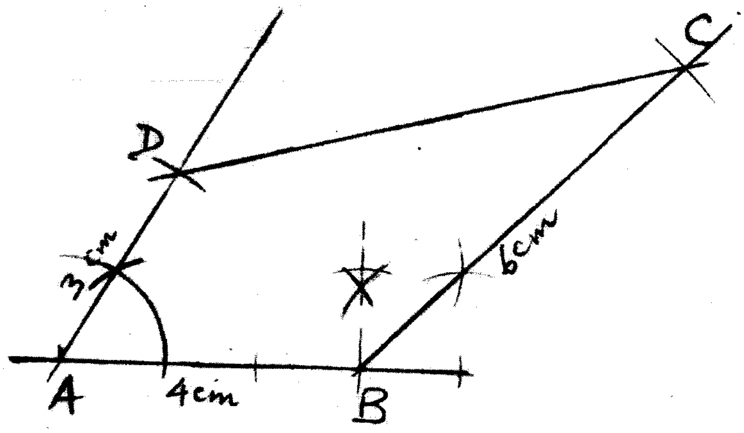
(ii) the distance covered by the body to attain the maximum velocity. (3 marks)

5.0 THE YEAR 2012 KCSE EXAMINATION MARKING SCHEMES

5.1 MATHEMATICS (121 AND 122)

5.1.1 Mathematics Alternative A Paper 1 (121/1)

1.	$\dfrac{\frac{6}{5}-\frac{4}{3}}{\frac{1}{8}-\frac{1}{4}}-\dfrac{14}{15}$		
	$=\dfrac{-\frac{2}{15}}{-\frac{1}{8}}-\dfrac{14}{15}$	M1 M1	numerator denominator
	$=\dfrac{16}{15}-\dfrac{14}{15}$	M1	
	$=\dfrac{2}{15}$	A1	
		4	
2.	$\dfrac{1}{0.216}=4.630$	B1	
	$\dfrac{\sqrt[3]{0.512}}{0.216}=0.8\times4.630$	M1	
	$=3.704$	A1	
		3	
3.	$(2x^2-3y^3)^2+12x^2y^3$		
	$=4x^4-12x^2y^3+9y^6+12x^2y^3$	M1	
	$=4x^4+9y^6$	A1	
		2	
4.	$\dfrac{24}{2}=\dfrac{1}{2}\times8\times x\sin30^\circ$	M1	or equivalent
	$x=\dfrac{12}{4\sin30}=6cm$		
	$perimeter=2(6+8)=28$	M1 A1	
		3	
5.	$9^{2y}\times2^x=9\times8$		
	$(3^2)^{2y}\times2^x=3^2\times2^3$	M1	
	$(3^2)^{2y}=3$ and $2^x=2^3$		
	$4y=2$ and $x=3$	M1	equating indices
	$y=\dfrac{1}{2}$ and $x=3$	A1	
		3	

6.	LCM of 9, 15 and 21 $3^2 \times 5 \times 7 = 315$ minutes Last time of ringing together 11:00 $\underline{5:15}$ — 5:45 p.m.	B1 M1 A1 3	For 315 minutes For subtraction
7.	$\frac{x}{8} = \frac{x}{20} + \frac{1}{4}$ $\frac{x}{8} - \frac{x}{20} = \frac{1}{4}$ $\Rightarrow \frac{3x}{40} = \frac{1}{4}$ $x = 3\frac{1}{3}$ Distance to shopping centre $12 - 3\frac{1}{3} = 8\frac{2}{3}$ km	M1 A1 B1 3	
8.	 Construction of 135^0 angle between lines AB = 4 cm and BC = 6 cm Construction of 60^0 angle between lines AB = 4 cm and AD = 3 cm Completion of quadrilateral ABCD $\angle BCD = 31^\circ \pm 1^\circ$	B1 B1 B1 B1 4	

9.	$\begin{pmatrix}3\\-2\end{pmatrix} - \begin{pmatrix}2\\3\end{pmatrix}$	M1	
	$= \begin{pmatrix}1\\-5\end{pmatrix}$		
	magnitude $= \sqrt{1^2 + (-5)^2}$	M1	
	$= \sqrt{26} \simeq 5.1$	A1	
		3	
10.	$x = \tan^{-1}\frac{3}{7} = 23.20°$	B1	
	$Cos(90 - 23.2)° = 0.3939$	B1	
		2	
11.	$A^2 = \begin{pmatrix}1 & 0\\-2 & 3\end{pmatrix}\begin{pmatrix}1 & 0\\-2 & 3\end{pmatrix} = \begin{pmatrix}1 & 0\\-8 & 9\end{pmatrix}$	B1	
	$2AB = 2\begin{pmatrix}1 & 0\\-2 & 3\end{pmatrix}\begin{pmatrix}3 & 0\\2 & 1\end{pmatrix} = 2\begin{pmatrix}3 & 0\\0 & 3\end{pmatrix} = \begin{pmatrix}6 & 0\\0 & 6\end{pmatrix}$	B1	
	$C = 2AB - A^2 = \begin{pmatrix}6 & 0\\0 & 6\end{pmatrix} - \begin{pmatrix}1 & 0\\-8 & 9\end{pmatrix}$	M1	
	$= \begin{pmatrix}5 & 0\\8 & -3\end{pmatrix}$	A1	
		4	
12.	$\log_{10}\left(\frac{x^2}{2^3} \times 32\right) = 2$	M1	
	$\frac{x^2}{2^3} \times 2^5 = 100$	M1	dropping logs.
	$4x^2 = 100$		
	$x = \sqrt{25} = \pm 5$	A1	
	$x = 5$		
		3	

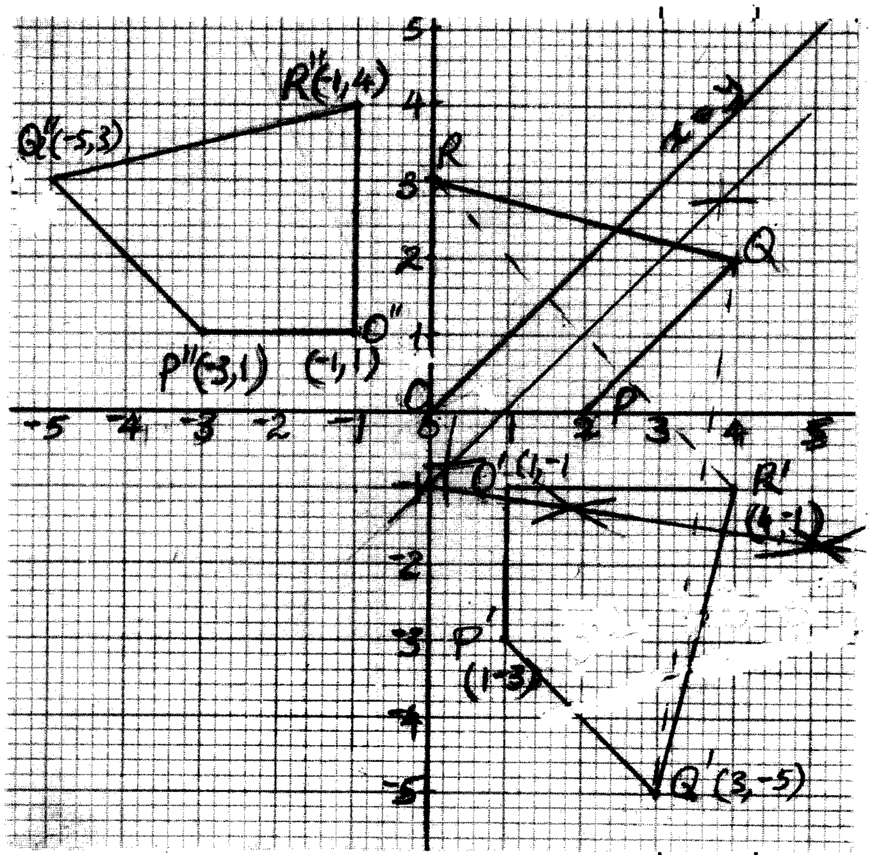
13.	$2y = 4x + 5 \Rightarrow y = 2x + \frac{5}{2}$ gradient, M_1 of line = 2 gradient, M_2, of perpendicular is given by $2M_2 = -1 \Longrightarrow M_2 = -\frac{1}{2}$ equation of line L $\frac{y-1}{x-3} = -\frac{1}{2}$ $y = -\frac{1}{2}x + \frac{5}{2}$	B1 M1 A1 3	
14. (a)	195250 Chinese Yuan into Kenya Shillings $= 195250 \times 12.34 = 2409385$	B1	
(b)	Balance: $= 2409385 - 1258000$ $= 1151385$ Balance in S.A. Rand $= \frac{1151385}{11.37}$ $= 101265$	M1 M1 A1 4	

15.	Volume of solid $= \frac{1}{3} \times \frac{22}{7} \times 10.5^2 \times 15 - \frac{22}{7} \times 3.5^2 \times 8$ $= 1732.5 - 308$ $= 1424.5\ cm^3$	M1 M1 A1 3	
16.	$\left.\begin{array}{l}4(A-2) = B+2 \\ 2(A+10) = B+10\end{array}\right\}$ $4A - B = 10 \ldots(i)$ $\mp 2A \pm B = \pm 10 \ldots(ii)$ $2A = 20$ $\Longrightarrow A = 10$ Substitute A = 10 in (i) $4 \times 10 - B = 10$ $\Longrightarrow B = 30$	M1 M1 A1 3	for both values of A and B
17. (a) (b)	modal class 40 - 44 (i) mid points: $22, 27, 32, 37, 42, 47, 52, 57$ $\frac{22 \times 2 + 27 \times 15 + 32 \times 18 + 37 \times 25 +}{101}$ $\frac{42 \times 30 + 47 \times 6 + 52 \times 3 + 57 \times 2}{101}$ $= 37.25$	B1 B1 M1 M1 A1	 fx for $\frac{\Sigma fx}{\Sigma f}$

	(ii) Cumulative frequencies $2, 17, 35, 60, 90, 96, 99, 101$ $\frac{16}{25} \times 5$ $= 3.2$ $34.5 + 3.2$ $= 37.7$ difference 37.7 - 37.25 $= 0.45$	 B1 M1 M1 A1 B1 10	
18. (a)	$\|AB\| = \sqrt{169 - 25} = 12$	B1	
(b)	$2 \times 5 \times 12 + 2 \times 5 \times 15 + 2 \times 12 \times 15$ $= 630cm^2$	M1 M1 A1	3 pairs of congruent faces summing up
(c)	volume $= 5 \times 12 \times 15cm^3$ mass $= 7.6 \times 5 \times 12 \times 15$ $= 6840gm$ $= \frac{6840}{1000}$ $= 6.84kg$	M1 M1 M1 A1	 division by 1000
(d)	$\frac{150 \times 120 \times 100\ cm^3}{15 \times 12 \times 5\ cm^3}$ $= 2000$	M1 A1 10	

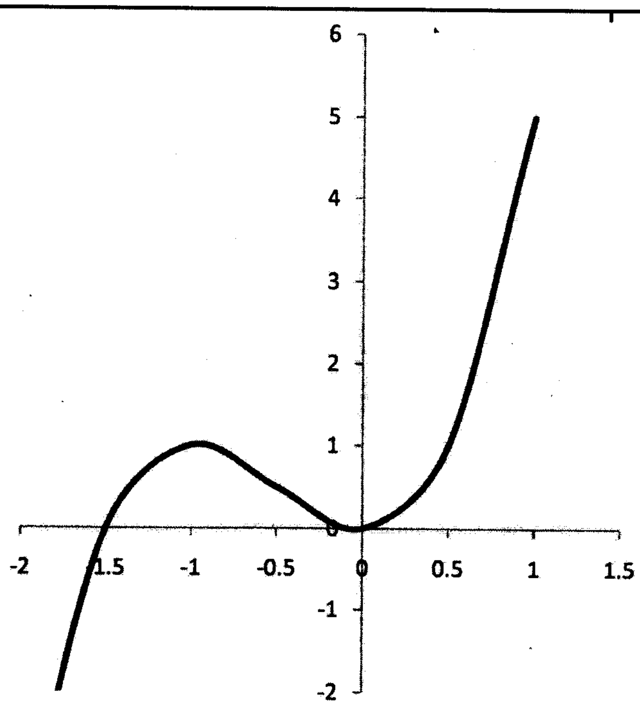
19. (a)	*Ratio: copper: zinc: tin*		
	copper zinc tin		
	3 $\frac{2}{3}$ 5		
	9 6 10	M1	
	Copper : zinc : tin = 9 : 6 : 10	A1	
(b) (i)	mass of tin		
	$= 250 \times \frac{10}{25}$	M1	
	$= 100kg$	A1	
(ii)	mass of zinc and tin in alloy B:		
	mass of copper $= \frac{70}{100} \times 90$	M1	
	$= 63$		
	$\therefore$ mass of zinc and tin:		
	$= 250 - 63$	M1	
	$= 187$	A1	
	amount of tin in alloy A than B:		
(c)	mass of tin in alloy B		
	$= \frac{8}{11} \times 187$	M1	
	$= 136$		
	difference:		
	$136 - 100$	M1	
	$= 36$	A1	
		10	

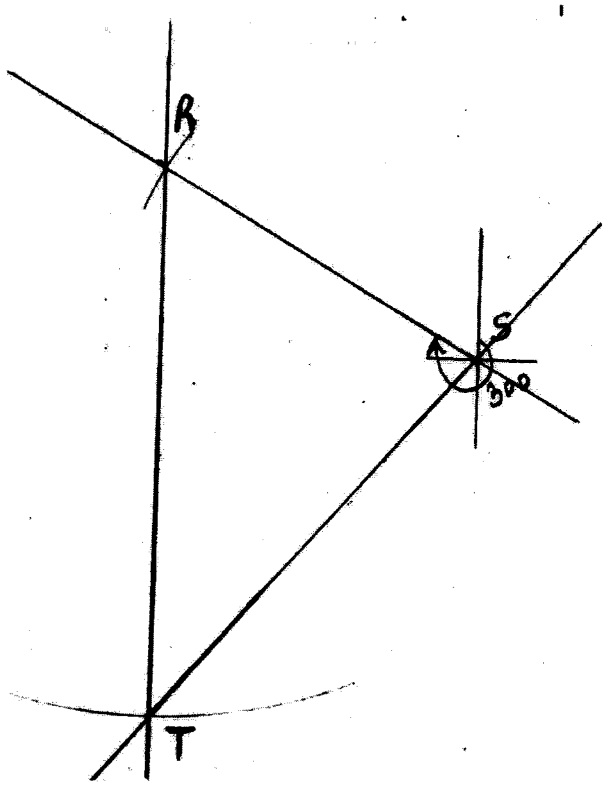
20. (a)	$\frac{1}{x-2} - \frac{2}{x+5} = \frac{3}{x+1}$		
	$\frac{x+5-2(x-2)}{(x-2)(x+5)} = \frac{3}{x+1}$		
	$\frac{-x+9}{x^2+3x-10} = \frac{3}{x+1}$	M1	
	$4x^2 + x - 39 = 0$	A1	
	$(4x+13)(x-3) = 0$	M1	
	$x = 3$ *or* $x = -3\frac{1}{4}$	A1	
(b)	mean for second set of tests $= \frac{147}{y+2}$	B1	
	$\frac{120}{y} - \frac{147}{y+2} = 3$	M1	
	$\frac{120y + 240 - 147y}{y(y+2)} = 3$		
	$-27y + 240 = 3y^2 + 6y$	M1	elimination of denominator
	$-9y + 80 = y^2 + 2y$		
	$y^2 + 11y - 80 = 0$	A1	
	$(y-5)(y+16) = 0$	M1	factorization
	$y = 5$ *or* -16 No. of tests: 5 + 2 = 7	A1	
		10	

21.			
	a) (i) OPQR √drawn	B1	
	$O'P'Q'R'$ √drawn	B1	
	(ii) Perpendicular bisectors √drawn (at least 2)	B1	
	centre of rotation $(0, -1)$ shown	B1	
	angle of rotation -90°	B1	
	b) line of reflection x = y drawn	B1	can be implied
	quadrilateral $O''P''Q''R''$ drawn	B1	
	c) (i) directly congruent quads: OPQR and O'P'Q'R'	B1	
	(ii) Oppositely congruent quads.:		
	OPQR and O"P"Q"R"	B1	
	O'P'Q'R' and O"P"Q"R"	B1	
		10	

22. (a) (i)	x - intercepts when y= 0 $x^2(2x+3)=0$ $x=0$ *and* $x=-\frac{3}{2}$	M1 A1	
(ii)	y - intercept when x = 0, y = 0	B1	
(b) (i)	stationary points of curve $\frac{dy}{dx}=6x^2+6x$ stationery points when $\frac{dy}{dx}=0$ i.e. $6x^2+6x=0$ $6x(x+1)=0$ $x=0$ *or* $x=-1$ $\therefore$ stationary points are: $(0,0)$ and $(-1,1)$	M1 A1 B1	
(ii)	see table below	B1	checking points
	minimum point (0,0) maximum point (-1,1)	B1	for both

x	-2	$-1\frac{1}{2}$	-1	$-\frac{1}{2}$	0	$\frac{1}{2}$	1
$\frac{dy}{dx}$	12	$4\frac{1}{2}$	0	$-1\frac{1}{2}$	0	$4\frac{1}{2}$	12

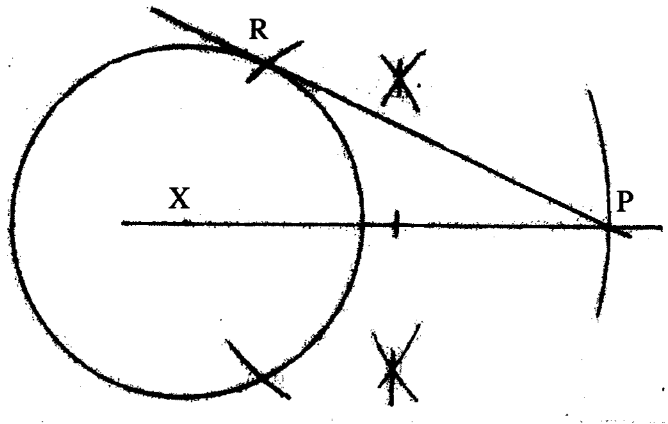
(c)			
	points plotted at $\left(-1\frac{1}{2}, 0\right), (-1, 1)$ *and* $(0, 0)$	B1	
	smooth curve	B1	
		10	

23. (a)			
	√ location of R	B1	length 5 cm and bearing 300°
	√ location of T	B1	length 7.5 cm; south of R
	*complete*Δ	B1	
(b) (i)	Distance TS: $6.6(\pm.1)cm$	B1	
	conversion $6.6 \times 60 = 396$ m	B1	
(ii)	Bearing of T from S $180 + 41°(\pm 1°) = 221°$	B1	
(c)	area of field $\angle TRS = 60°$	B1	
	$area = \frac{1}{2} \times 300 \times 450 \sin 60°$	M1	
	$= \frac{58456.71476}{10000}$	M1	
	=5.8 ha	A1	
		10	

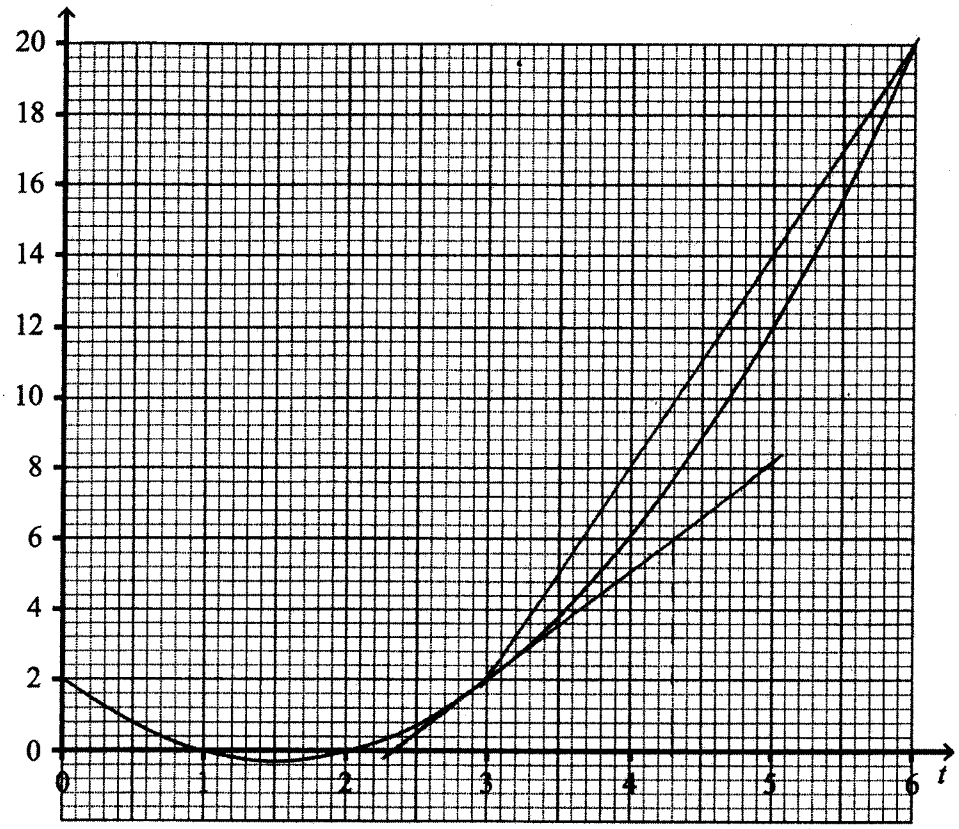
24. (a)	length of RT:		
	$=\frac{3}{5}\times 10$	M1	
	$= 6$ cm	A1	
(b) (i)	Perpendicular distance between PQ & RS		
	$= 10 \sin 40$	M1	
	$= 6.4$ cm	A1	
(ii)	$\frac{TS}{\sin 40} = \frac{6}{\sin 60}$		
	$TS = \frac{6 \times \sin 40}{\sin 60}$	M1	
	$= 4.5$ cm	A1	
(c)	length RS using cosine rule		
	$RS^2 = 6^2 + 4.5^2 - 2 \times 4.5 \times 6 Cos\, 80$	M1	
	$= 46.87299841$		
	RS = 6.8	A1	
(d)	area of ΔRST		
	$= \frac{1}{2} \times 6 \times 4.5 \sin 80$	M1	
	$=13.3$	A1	
		10	

5.1.2 Mathematics Alternative A Paper 2 (121/2)

1.	$\dfrac{5\log 4 - 4\log 5}{\frac{1}{5}\log 4 + \frac{1}{4}\log 5}$ $= \dfrac{3.010299957 - 2.795880017}{0.120411998 + 0.174742501}$ $= 0.726466785$ $\simeq 07265$ (4 s.f.)	M1 A1 2	
2.	$\left(\dfrac{r}{p}\right)^2 = \dfrac{m^2}{n-1}$ $n - 1 = \left(\dfrac{mp}{r}\right)^2$ $n = \left(\dfrac{mp}{r}\right)^2 + 1$	M1 M1 A1 3	squaring
3.	Fraction filled by inlet tap in $1h = \dfrac{1}{6}$ Fraction filled when two taps open in $1h = \dfrac{1}{10}$ $\therefore$ fraction emptied by outlet tap in $1h = \dfrac{1}{6} - \dfrac{1}{10}$ $= \dfrac{1}{15}$ Time for outlet tap to empty tank = 15h	B1 M1 A1 3	for $\dfrac{1}{6}$ or $\dfrac{1}{10}$
4.	$\underset{\sim}{R} = 6\underset{\sim}{i} - 9\underset{\sim}{j} + 3\underset{\sim}{k} + 6\underset{\sim}{i} - 8\underset{\sim}{j} - 6\underset{\sim}{k}$ $= 12\underset{\sim}{i} - 17\underset{\sim}{j} - 3\underset{\sim}{k}$ $\lvert R \rvert = \sqrt{12^2 + 17^2 + 3^2}$ $= \sqrt{442}$ $= 21.02 \simeq 21$ (2 s.f.)	B1 M1 A1 3	
5.	Sin $(2t + 10)° = 0.5$ $2t + 10 = 30°, 150°$ $t = 10°, 70°$	B1 B1 2	

6.	 Drawing circle Fixing point P Bisecting XP and drawing tangent RP = $5.4 \pm 0.1cm$	B1 B1 B1 B1 4	
7.	Amount for Kago $= 30000 + \frac{12}{100} \times 30000 \times 5$ $= 48000$ Compound interest rate for Nekesa $30000\left(1 + \frac{r}{100}\right)^5 = 48000$ $\left(1 + \frac{r}{100}\right)^5 = \frac{48000}{30000} = 1.6$ $1 + \frac{r}{100} = \sqrt[5]{1.6}$ $r = 100(1.098560543 - 1)$ $= 9.9\%$	B1 M1 M1 A1 4	
8.	Differences from assumed mean $-6 - 2 + 0 + 2 + 3 + 6 + 9 - 5 + 6 + 3 + 9$ $-2 + 3 - 6 - 2 + 3 + 2 + 0 + 6 + 9 = 38$ $\therefore mean = 96 + \frac{38}{20}$ $= 97.9$	M1 M1 A1 3	differences from the assumed mean

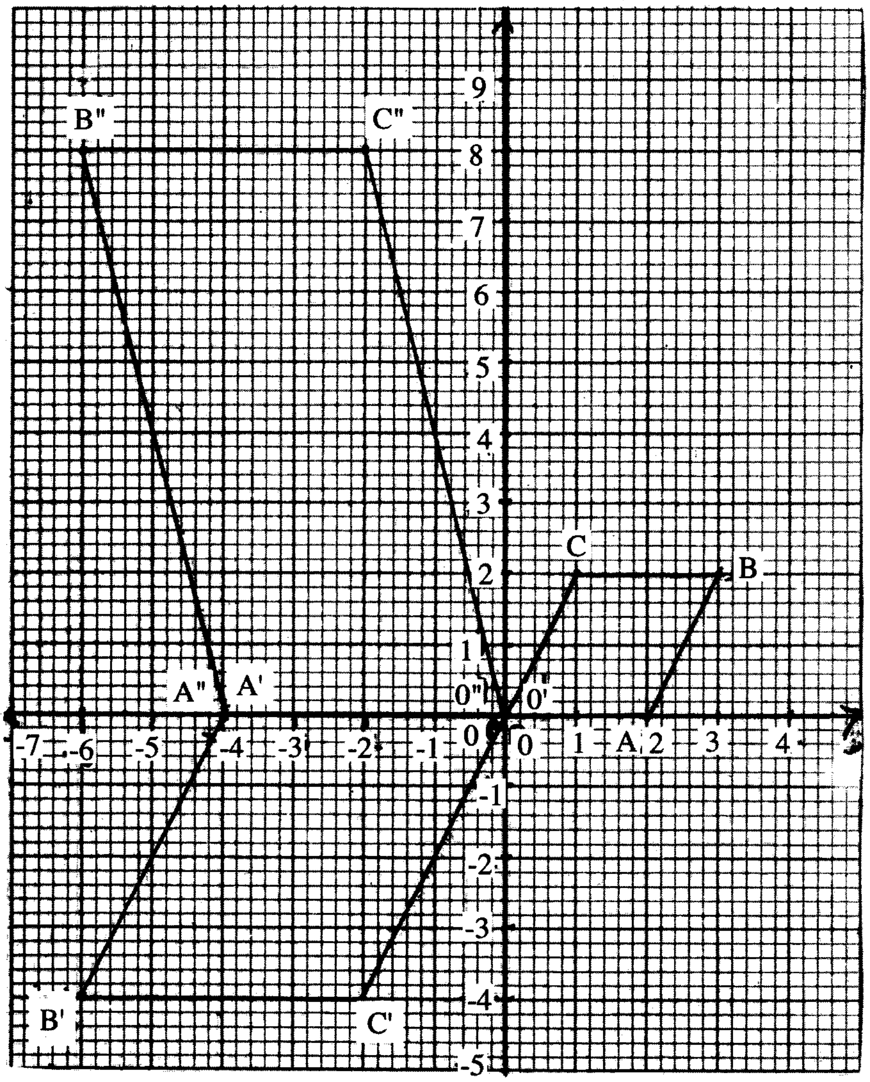
9.	$x + y = 17$..........(i) $xy - 5x = 32$......(ii) from (i) $y = 17 - x$ substituting $y = 17 - x$ in (ii) $x(17 - x) - 5x = 32$ $17x - x^2 - 5x = 32$ $x^2 - 12x + 32 = 0$ $(x - 4)(x - 8) = 0$ $x = 4$ or $x = 8$ substituting x = 4 in (i) $4 + y = 17 \Rightarrow y = 13$ substituting x = 8 in (ii) $8 + y = 17 \Rightarrow y = 9$	M1 M1 A1 B1 4	for substitution or elimination for both 4 and 8 for both 13 and 9
10	$\frac{\sqrt{5}}{\sqrt{5}-2} = \frac{\sqrt{5}}{\sqrt{5}-2} \times \frac{\sqrt{5}+2}{\sqrt{5}+2}$ $= \frac{5 + 2\sqrt{5}}{5 - 4}$ $= 5 + 2\sqrt{5}$	M1 A1 2	
11.	minimum possible area $= \frac{1}{2}(6.35 \times 3.45)$ $= 10.95375\text{ cm}^2$ maximum possible area $= \frac{1}{2} \times 6.45 \times 3.55$ $= 11.44875\text{ cm}^2$ maximum absolute error in area $= \frac{11.44875 - 10.95375}{2}$ $= 0.2475\text{ cm}^2$	M1 M1 A1 3	for both expressions - min. and max. areas
12.	(a) $(1+x)^7 = 1^7 + 7 \times 1^6 \times x + 21 \times 1^5 \times x^2 + 35 \times 1^4 \times x^3 + \ldots$ $= 1 + 7x + 21x^2 + 35x^3$ (b) $(0.94)^7 = [1 + (-0.06)]^7$ $= 1 + 7 \times (-0.06) + 21 \times (-0.06)^2 + 35 \times (-0.06)^3$ $= 1 - 0.42 + 0.0756 - 0.00756$ $= 0.64804$	B1 M1 A1 3	

13			
	(a) Average rate of change between t = 3 and t = 6 $\frac{20-2}{6-3}$	M1	
		A1	
	$= \frac{18}{3} = 6$		
	(b) Gradient at t = 3 seconds $\frac{6-0}{4.3-2.3} = \frac{6}{2}$	M1	or equivalent
	$= 3 \pm 0.1$	A1	
		4	

14.	(a) Let UV be x cm: $VT \times UT = ST^2$ $(x + 8)8 = 12^2$ $8x = 144 - 64$ $= 80$ $x = 10$ cm (b) $VX = \frac{2}{5} \times 10 = 4$ cm $XU = 10 - 4 = 6$ cm $SX \times XW = VX \times XU$ $SX \times 3 = 4 \times 6$ $SX = 8$ cm	M1 A1 M1 A1 4	
15.	$P \propto \frac{Q}{\sqrt{R}} \Rightarrow P = \frac{kQ}{\sqrt{R}}$ $8 = \frac{k \times 10}{\sqrt{16}}$ $k = 3.2$ $P = \frac{3.2Q}{\sqrt{R}}$	M1 A1 B1 3	
16.	$OC = \frac{\sqrt{24^2 + 10^2}}{2}$ $= 13$ $\angle VCO = \cos^{-1}\frac{13}{26}$ $= 60°$	M1 M1 A1 3	

17.	(a) (i) $180000 + (11-1)x = 288000$ $10x = 108000$ $x = 10800$	M1 A1	
	(a) (ii) $S_{11} = \frac{11}{2}(180000 + 288000)$ $= 2574000$	M1 A1	
	(b) $\frac{150000 \times 1.1^{10}}{12}$ $= 32422$	M1 A1	
	(c) (i) $\frac{[150000 \times (1.1^{11} - 1)]}{(1.1 - 1)}$ $= 2779675$	M1 A1	
	(c) (ii) Difference between monthly averages for the 11 years $\frac{2779675 - 2574000}{11 \times 12}$ $= 1558$	 M1 A1	
		10	
18.	(a) $\begin{pmatrix} -2 & 0 \\ 0 & -2 \end{pmatrix} \begin{array}{cccc} O & A & B & C \\ \left(\begin{array}{cccc} 0 & 2 & 3 & 1 \\ 0 & 0 & 2 & 2 \end{array}\right) \end{array} = \begin{array}{cccc} O' & A' & B' & C' \\ \left(\begin{array}{cccc} 0 & -4 & -6 & -2 \\ 0 & 0 & -4 & -4 \end{array}\right) \end{array}$ co-ordinates of O'A'B'C' O' (0, 0), A' (-4, 0), B' (-6, -4), C' (-2, -4)	M1 A1	

18. continued



B1	OABC √ drawn
B1	O'A'B'C' √ drawn
B1	O"A"B"C" √ drawn

(b)

$$\begin{pmatrix}1 & 0\\ 0 & -2\end{pmatrix}\begin{pmatrix}0 & -4 & -6 & -2\\ 0 & 0 & -4 & -4\end{pmatrix} = \begin{array}{c} \begin{array}{cccc} O'' & A'' & B'' & C'' \end{array} \\ \begin{pmatrix}0 & -4 & -6 & -2\\ 0 & 0 & 8 & 8\end{pmatrix} \end{array}$$

M1

A1

(c)

$$\begin{pmatrix}1 & 0\\ 0 & -2\end{pmatrix}\begin{pmatrix}-2 & 0\\ 0 & -2\end{pmatrix} = \begin{pmatrix}-2 & 0\\ 0 & 4\end{pmatrix}$$

M1 or equivalent

inverse $\frac{1}{-8}\begin{pmatrix}4 & 0\\ 0 & -2\end{pmatrix}$

M1

$= \begin{pmatrix}-\frac{1}{2} & 0\\ 0 & \frac{1}{4}\end{pmatrix}$

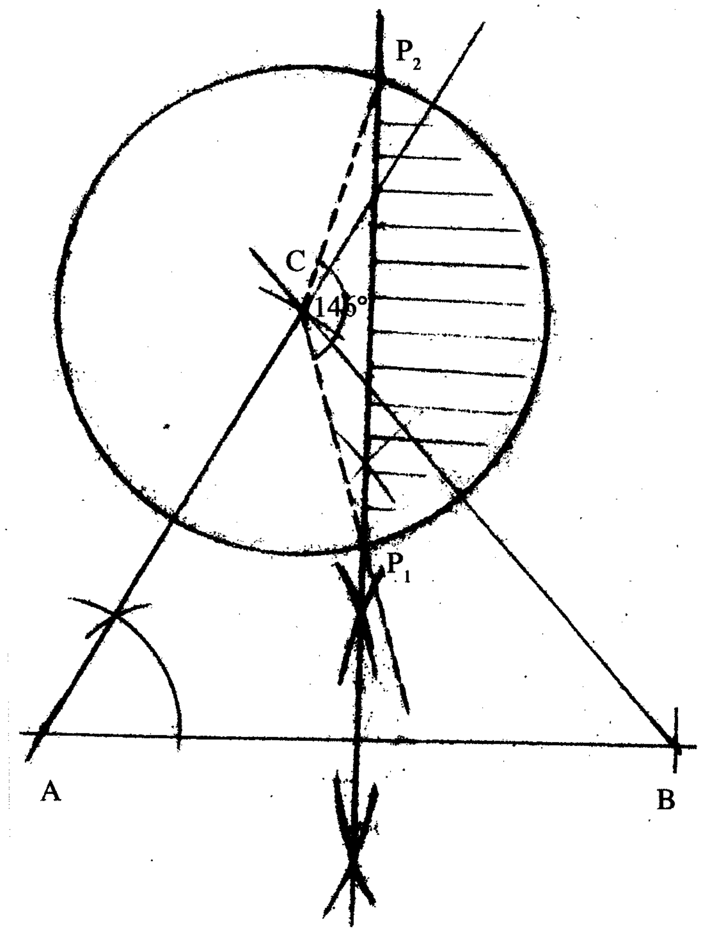
A1

10

19.	(a) (i) $\underset{\sim}{PN} = \frac{5}{6}\underset{\sim}{q} - \underset{\sim}{p}$	B1	
	(ii) $\underset{\sim}{QM} = \frac{2}{5}\underset{\sim}{p} - \underset{\sim}{q}$	B1	
	(b) (i) $\underset{\sim}{OX} = \underset{\sim}{p} + k\left(\frac{5}{6}\underset{\sim}{q} - \underset{\sim}{p}\right)$	B1	
	$\underset{\sim}{OX} = \underset{\sim}{q} + r\left(\frac{2}{5}\underset{\sim}{p} - \underset{\sim}{q}\right)$	B1	
	(ii) $\underset{\sim}{p} + k\left(\frac{5}{6}\underset{\sim}{q} - \underset{\sim}{p}\right) = \underset{\sim}{q} + r\left(\frac{2}{5}\underset{\sim}{p} - \underset{\sim}{q}\right)$	M1	
	$\underset{\sim}{p}(1-k) + \frac{5}{6}k\underset{\sim}{q} = \underset{\sim}{q}(1-r) + \frac{2}{5}r\underset{\sim}{p}$		
	$1 - k = \frac{2}{5}r$ and $1 - r = \frac{5}{6}k$	M1	
	$1 - r = \frac{5}{6}\left(1 - \frac{2}{5}r\right)$	M1	
	$1 - r = \frac{5}{6} - \frac{1}{3}r$		
	$\frac{1}{6} = \frac{2}{3}r \Rightarrow r = \frac{1}{4}$		
	$k = 1 - \frac{2}{5}r \Rightarrow k = 1 - \frac{2}{5} \times \frac{1}{4} = \frac{9}{10}$	A1	for both values of **r** and **k**
	(iii) $\underset{\sim}{QX} = \frac{1}{4}\underset{\sim}{QM}$	M1	
	$\underset{\sim}{MX} = \frac{3}{4}\underset{\sim}{QM}$		
	$\therefore \underset{\sim}{MX} : \underset{\sim}{XQ} = \frac{3}{4} : \frac{1}{4} = 3 : 1$	A1	
		10	

20.	(a) (i) July basic salary $= 17000 \times 1.02$ $= 17340$	M1 A1	
	(ii) Total taxable income $= 17340 + 6000 + 2500 + 1800$ $= 27640$	M1 A1	
	(b) Gross tax		
	1st bracket: $9680 \times 10\% = 968$	M1	
	2nd bracket: $(18800 - 9680) \times 15\% = 1368$	M1	
	3rd bracket: $(27640 - 18800) \times 20\% = 1768$	M1	$[27649 - (9680 + 9120)]20\%$
	Gross tax: $968 + 1368 + 1768$ $= 4104$	M1 A1	
	Net tax: $4104 - 1056 = 3048$	B1	
		10	

21.

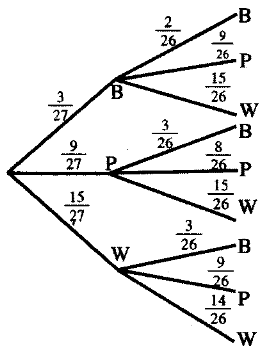


B1 construction of 60°

B1 completion of Δ

(a) locus of P	B1	
locus of Q	B1	
(b) (i) shading region R	B2	
(ii) area of shaded region area of minor sector P_1CP_2 $= \frac{146}{360} \times \pi \times 3.5^2$ $\simeq 15.6\ cm^2$	M1	($\angle P_1CP_2 = 146° \pm 1°$)
area of ΔP_1CP_2 $\frac{1}{2} \times 3.5^2 \sin 146°$ $\simeq 3.4\ cm^2$	M1	
∴ shaded area 15.6 - 3.4	M1	
=12.2 cm²	A1	
	10	

22.	(a) distance from T to U $= 2 \times 6370 \times \frac{22}{7} \times \frac{12}{360}$	M1	
	speed $= \dfrac{2 \times 6370 \times \frac{22}{7} \times \frac{12}{360}}{1\frac{1}{3}}$	M1	
	$= 1001$ km/h	A1	
	(b) time $= \dfrac{2 \times 6370 \times \frac{22}{7} \times \frac{30}{360} \cos 9^\circ}{1001 \times \frac{90}{100}}$	M1 M1	
	$= 3.658104965$ h $\simeq 3$ h 39 min	A1	
	(c) Arrival time at U 0700 + 1h 20 min = 0820 h		
	Departure time at U 0820 + 30 min = 0850 h	M1	
	Time difference between U and V $\frac{35-5}{360} \times 24$ = 2h	M1	or equivalent
	Arrival time at V (local time) 0850h + 3h 39min - 2h = 1029h	M1 A1	
		10	

23.	(a) (i) P (brown) $= \frac{3}{27}$	B1	
	(ii) P(pink or white) $= \frac{9}{27} + \frac{15}{27}$	M1	
	$= \frac{8}{9}$	A1	
	(b) (i) P(white and brown) $= \frac{15}{27} \times \frac{3}{26} + \frac{3}{27} \times \frac{15}{26}$	M1 M1	
	$= \frac{5}{78} + \frac{5}{78} = \frac{5}{39}$	A1	
	(ii) white, white + pink, pink + brown, brown $= \frac{15}{27} \times \frac{14}{26} + \frac{9}{27} \times \frac{8}{26} + \frac{3}{27} \times \frac{2}{26}$	M1 M1 M1	
	$= \frac{35}{117} + \frac{4}{39} + \frac{1}{117} = \frac{16}{39}$	A1	
		10	
24.	(a) (i) $\frac{dv}{dt} = 4 - t$		
	$V = \int (4-t)dt$ $= 4t - \frac{1}{2}t^2 + c$	B1	
	when t = 0, v = 3 m/s $\therefore 3 = 4 \times 0 - \frac{1}{2} \times 0^2 + c$ $3 = c$	B1	
	$\therefore V = 4t - \frac{1}{2}t^2 + 3$	B1	
	(ii) when t = 2 seconds $V = 4 \times 2 - \frac{1}{2} \times 2^2 + 3$	M1	
	$= 8 - 2 + 3$ $= 9\, m/s$	A1	
	(b) (i) At maximum velocity $\frac{dv}{dt} = 0$		
	i.e. 4 - t = 0	M1	
	t = 4 seconds	A1	
	(ii) $\int_0^4 4t - \frac{1}{2}t^2 + 3 = \frac{4}{2}t^2 - \frac{1}{2} \times \frac{1}{3}t^3 + 3t\Big]_0^4$	M1	
	$= 2t^2 - \frac{1}{6}t^3 + 3t\Big]_0^4$ $= [2 \times 16 - \frac{1}{6} \times 64 + 12] - 0$	M1	
	$= 32 - 10\frac{2}{3} + 12 = 33\frac{1}{3}$	A1	
		10	