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THE KENYA NATIONAL EXAMINATINOS COUNCIL

Kenya Certificate of Secondary Education

MATHEMATICS Alt. A
Paper 2

MARKING SCHEME
(CONFIDENTIAL)

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This marking scheme consists of 17 printed pages.

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Turnover

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No.	Marking scheme	marks	comments
1.	$\frac{\sqrt{5}+3}{\sqrt{5}-2} = \frac{(\sqrt{5}+3)}{(\sqrt{5}-2)} \times \frac{(\sqrt{5}+2)}{(\sqrt{5}+2)}$ $= \frac{5+2\sqrt{5}+3\sqrt{5}+6}{5-4}$ ✓ $= 11 + 5\sqrt{5}$ ✓	M1 A1 2	Expanded numerator Denominator rationalised } Combined
2.	Let the ratio of X to Y = $x : y$ $\frac{60x + 72y}{x + y} = 70$ ✓M_1 $60x + 72y = 70x + 70y$ $10x = 2y$ $\frac{x}{y} = \frac{1}{5}$ ✓A_1 (Accept $\frac{2}{10}$) ∴ Ratio $x : y$ = 1:5 ✓B_1	M1 A1 B1 3	Let the ratio of X to Y = $1 : n$ $\frac{60 + 72n}{1 + n} = 70$ M1 $60 + 72n = 70 + 70n$ $2n = 10$ $n = 5$ A1 ∴ Ratio $x : y$ = 1:5 B1
3.	$P \propto \frac{1}{L^2}$ $P = \frac{K}{L^2}$ $0.625 = \frac{K}{16}$ → M_1 $K = 10$ When L = 0.2 $P = \frac{10}{0.2^2} = 250$ ✓M_1 ✓A_1	M1 A1 3	Correct substitution $(0.625 = \frac{k}{4^2})$. for $P = \frac{10}{0.2^2}$ for 250.

60 72 → 70 → 2 : 10 → 1 : 5 B_1 (both correct)

121/2 MS

(2) $x + y = 1$
$60x + 72y = 70$ } M_1 formation of eqn 2

$x = \frac{1}{6}$ — A_1
$y = \frac{5}{6}$
1 : 5 ⇒ B_1

$x : y = 5 : 1$

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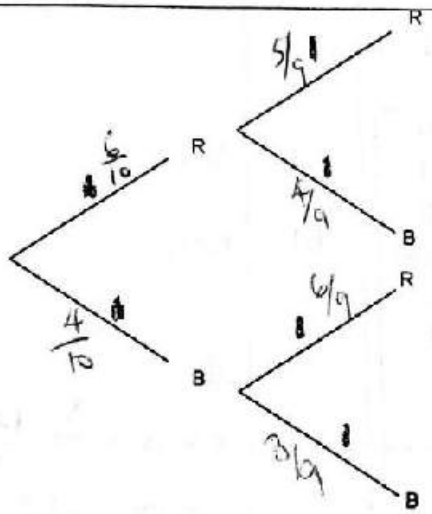
4.	Angle at centre = $2 \times 150°$ $= 300°$	M1 A1 2	(May be implied at 300°)
5.	$x = 13 - 3y$ $(13-3y)^2 + 3y^2 = 43$ → $169 - 78y + 12y^2 = 43$ $12y^2 - 78y + 126 = 0$ $2y^2 - 13y + 21 = 0$ $(2y-7)(y-3) = 0$ → $y = 3$ or 3.5 → *When* $y = 3$, $x = 4$ *When* $y = 3.5$, $x = 2.5$ →	M1 M1 A1 B1 4	eliminating one variable correct attempt to solve the quadratic Both (x, y) pairs √ (When candidate substitutes in formula). (Award when pairing implied in substitution).
6. (a)		B1	
(b)	$P(RR \text{ or } BB) = \frac{6}{10} \times \frac{5}{9} + \frac{4}{10} \times \frac{3}{9}$ → $= \frac{1}{3} + \frac{2}{15}$ $= \frac{7}{15}$ →	M1 A1 3	If misses one of branches, give M_1 but lose A_1. Accept unsimplified forms. (Decimals ; A_0)

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7.

$\frac{dy}{dx} = 2x - 14$

At the turning point

$\frac{dy}{dx} = 2x - 14 = 0$ → M1 (Correct diff'n and equated to zero)

$\Rightarrow x = 7$ → A1

$y = 49 - 98 + 10 = -39$

Coordinate of turning point $= (7, -39)$ → B1

3

8.

Perimeter of sector $= \frac{60}{360} \times 2\pi r + 2r$ → M1

$= 2r + \frac{1}{3}\pi r$ → A1 (Award at earliest stage and must be in terms of π & r)

$= \frac{6r + \pi r}{3} = r\left(\frac{\pi}{3} + 2\right)$

2

9.

Score x	No. of students	$d = x - 69$	fd
59	2	-10	-20
61	3	-8	-24
65	5	-4	-20
k	6	k -69 (x)	6(k-69) (6x)
71	7	2	14
72	4	3	12
73	2	4	8
75	1	6	6
	$\Sigma f = 30$		

B1 for d (All Correct)

B1 for fd (All Correct).

$6x - 24$ $\quad$ $6x - 24$

$\frac{\Sigma fd}{\Sigma f} = \frac{6k - 438}{30} = -1.2$ M1

$6k = 402$

$k = 67$ A1

All

$\bar{x} = A + \frac{\Sigma f(x - A)}{N}$

$= 69 + -1.2 = 67.8$ B1

$\Sigma fx = 1632 + 6K$

Also,

$\bar{x} = \frac{1632 + 6k}{30}$ B1

Therefore,

$\frac{1632 + 6k}{30} = 67.8$ M1

$k = 67$ A1

4

Let $k - 69 = x$

$\frac{-24 + 6x}{30} = -1.2$

$x = -2$

$k - 69 = -2$ ---- M_1

$k = 67$ ---- A_1

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10.	Amplitude = 3 →	B1	
	Period = $\frac{360}{2} = 180°$ Or π^c →	B1	Condone if units are omitted
		2	
11.	(a)		
	$\sin\theta = \frac{25}{50}$ →	M1	
	$\theta = \sin^{-1}\left(\frac{1}{2}\right)$		
	$= 30°$ →	A1	
	(b)		
	$BE = \sqrt{(90^2 + 50^2 + 10^2)}$ →	M1	
	$= \sqrt{10700}$		
	$= 103.44$ →	A1	Condone no units
	Accept $103.48 \approx 104$	4	
12.	Tax before relief		
	$= \begin{cases} 10164 \times 0.1 + 9576 \times (0.15 + 0.2 + 0.25) \\ +2108 \times 0.3 \end{cases}$ →	M1	✓ comp. and addition of all taxes from all steps ✓
	$= 7394.4$		
	Net tax = Ksh $(7394.4 - 1162)$ →	M1	For subtraction of relief
	= Ksh 6232.4	A1	
		3	

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$a+b=\frac{b}{2}+a$

13.	$\mathbf{AB} = \begin{pmatrix}1\\2\end{pmatrix} - \begin{pmatrix}-3\\4\end{pmatrix} = \begin{pmatrix}4\\-2\end{pmatrix}$ $\mathbf{AC} = \begin{pmatrix}7\\-1\end{pmatrix} - \begin{pmatrix}-3\\4\end{pmatrix} = \begin{pmatrix}10\\-5\end{pmatrix}$	B1	for $\begin{pmatrix}4\\-2\end{pmatrix}$ and $\begin{pmatrix}10\\-5\end{pmatrix}$ or equivalents
2 gradients ⇒ B_1 equating 2 ⇒ B_1 Statement ⇒ B_1	$\begin{pmatrix}4\\-2\end{pmatrix} = k\begin{pmatrix}10\\-5\end{pmatrix}$ | k must work for both components. $k = 0.4$ *Thus* $\mathbf{AB} = 0.4\mathbf{AC}$ *and A is a common point.* *∴ Points A, B and C are collinear.*	M1 B_1 B_1	(Common point and parallelism must be stated)
	$AC=\frac{5}{3}BC$, $BC=\frac{3}{5}AC$, $AC=\frac{5}{2}AB$, $BC=\frac{3}{2}AB$, $AB=\frac{2}{3}BC$	3	
14.	Let $M^{-1} = \begin{pmatrix}a & b\\c & d\end{pmatrix}$ $\begin{pmatrix}a & b\\c & d\end{pmatrix}\begin{pmatrix}-7 & 2 & 4\\2 & -1 & -1\end{pmatrix} = \begin{pmatrix}-3 & 0 & 2\\2 & -1 & -1\end{pmatrix}$	M1	Can use any 2 points. Premultiplication Or equivalent
	$-7a + 2b = -3$ | $-7c + 2d = 2$ $2a - b = 0$ *or* $b = 2a$ | $2c - d = -1$ *or* $d = 2c+1$ $-7a + 2\times 2a = -3$ | $-7c + 2(2c+1) = 2$ $-3a = -3$ | $-3c = 0$ $a = 1,\ b = 2$ | $c = 0,\ d = 1$	M1 M1	formation of 2 pairs of eqns. Correct attempt to solve one pair.
	Therefore $M^{-1} = \begin{pmatrix}1 & 2\\0 & 1\end{pmatrix}$ $M = \begin{pmatrix}1 & -2\\0 & 1\end{pmatrix}$	A1 4	Alternative: $\begin{pmatrix}a & b\\c & d\end{pmatrix}\begin{pmatrix}-3 & 0 & 2\\2 & -1 & -1\end{pmatrix} = \begin{pmatrix}-7 & 2 & 4\\2 & -1 & -1\end{pmatrix}$ M_1 ⇒ Correct attempt to solve one pair. A_1 ⇒ for matrix M M_1 ⇒ for getting inverse A_1 ⇒ Accuracy.

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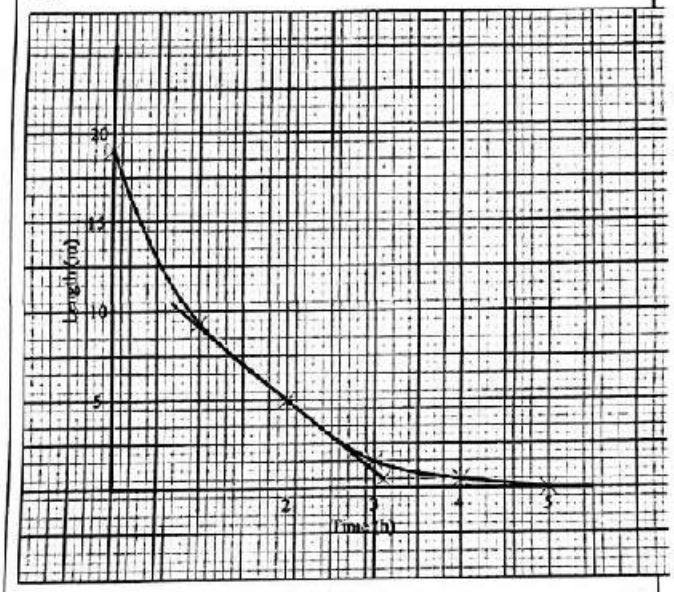
15.	$2 = \log 100$ ✓ $\log(7x-3) + \log 5^2 = \log 100 + \log(x+3)$ $\log\{25(7x-3)\} = \log\{100(x+3)\}$ → $25(7x-3) = 100(x+3)$ → $7x - 3 = 4x + 12$ $3x = 15$ $x = 5$ →	~~M1~~ B1 M1 M1 A1 a 04	For Log100 ⇒ 2 Log10 ⇒ $\text{Log}10^2$ (single logs on both sides). Dropping logs from expression
16.	(a)  (b) At t=2, $\frac{\Delta L}{\Delta t} = \frac{6-2}{1.2-3} = \frac{4}{-1.8}$ $= -2.22\ m/s$	P1 C1 ~~M1~~ B1 ~~A1~~ 4 B1	(All points correct) (smooth curve). Correct acceptable tangent drawn touching the curve at (2,5) follow through

⇒ use candidate's graph.
⇒ units m/h.
⇒ Tangent (2,5) and (2·5, 3·5) 7

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17.	(a)		
	$ar^3 = a + d$	B1	
	$ar^6 = a + 9d$	B1	
	(b)		
	From (a) above		
	$d = ar^3 - a$		
	$a + 9(ar^3 - a) = ar^6$	M1	Substitution for d
	$a + 9ar^3 - 9a = ar^6$		
	$ar^6 - 9ar^3 + 8a = 0$		
	$r^6 - 9r^3 + 8 = 0$	M1	Quadratic with r^6 without a (1 unknown)
	$(r^3 - 1)(r^3 - 8) = 0$	M1	Attempt to solve
	$r = 1$ or $r = 2$		
	$r = 2$	A1	
	(c)		
	$ar^9 = 5120$		
	$a = \frac{5120}{2^9} = 10$	B1	
	$a + d = 10 \times 2^3 = 80$		
	$\therefore d = 80 - 10 = 70$	B1	
	(d)		
	$S_{20} = \frac{20}{2}\{20 + 19 \times 70\}$	M1	Substitution of n, d and a in raw form.
	$= 13500$	A1	
		10	

Alternative (b)

$\frac{a+d}{a} = \frac{a+9d}{a+d}$ ✓ – M_1

$d^2 - 7ad = 0$

$d = 0$ or $d = 7a$

$a + 7a = ar^3$ ✓ – M_1

$8a = ar^3$

$8 = r^3$ – M_1

$r = 2$ – A_1

$S_n = \frac{20}{2}\{2 \times 10 - (20-1)70\}$

$a^2 + 9ad = a^2 + 2ad + d^2$

$7ad = d^2$

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18.

(a) Value of a plot after 2 years

$= 400\,000 \times 1.1^2$ — M1 — Can award in raw form

$=$ Ksh. 484 000 — A1

(b)

$558\,400 = 400\,000(1.1)^t$ — M1 — (can score in raw form).

$1.1^t = \dfrac{558\,400}{400\,000}$

$1.1^t = 1.396$

$t \log 1.1 = \log 1.396$ — M1 — t brought down.

$t = \dfrac{\log 1.396}{\log 1.1} = 3.500$ — M1 — t The subject

$=$ 3 years 6 months — A1 — Accept 42 month also

After 2 yrs

$558,400 = 484,000(1.1)^n$ ✓ M_1

$n \log 1.1 = \log 1.154$ ✓ M_1

$n = \dfrac{\log 1.154}{\log 1.1}$

$= 1.5$

$t = 1.5 + 2$ ✓ M_1

$= 3.5$

$\geq$ 3 yrs 6 months ✓ A_1

(c)

Let the number of plots bought be x

$x \times 400\,000 \times (1.1)^4 = 2\,928\,200$ — M1

$x = \dfrac{2\,928\,200}{400\,000 \times (1.1)^4} = \dfrac{2\,928\,200}{585\,640}$

$= 5$ — A1

Profit $= 2\,928\,200 - 5 \times 400\,000$

$= 928\,200$

% profit $= \left(\dfrac{928\,200}{2\,000\,000}\right) \times 100$ — M1

$= 46.41\%$ — A1

10

After 2 yrs

$558\,400 = 484\,000\,(1.1)^n$

$n = \dfrac{\log 1.154}{\log 1.1}$

Or equivalent

(2) $400,000\,(1.1)^4$ ✓ M_1

$= 585,640.$

$P = 585,640 - 400,000$

$= 185,640$ ✓ A_1

$P\% = \dfrac{185,640}{400,000} \times 100$ ✓ M_1

$= 46.41\%$ ✓ A_1

(3) $2928200 = P(1.1)^4$ ✓ M_1

$P = 2,000,000$

Profit $= 2,928,200$ ✓ A_1

$\text{Profit} = \dfrac{2928200}{2000000} \times 100$ ✓ M_1

$= 46.41\%$ ✓ A_1

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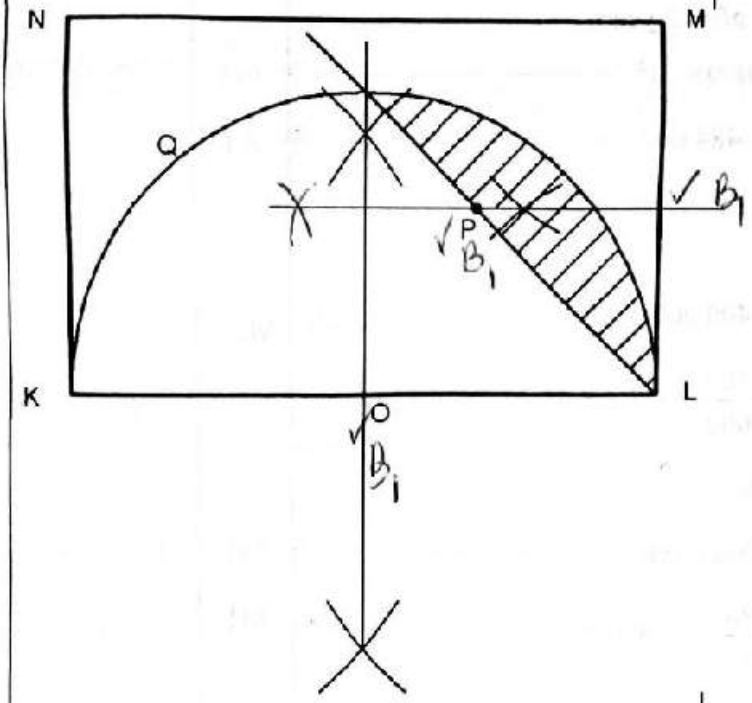
19.



(a) (i) ⊥ bisector to line LM	B1	bisector of $L\hat{M}N$
Bisector to ∠KLM	B1	
Position of P correctly ~~identified~~ labeled	B1	
(ii) ⊥ bisector to line KL	B1	
Correct identification of centre and used	B1	
Locus of Q correctly drawn	B1	
(b) (i) Correct region R shaded ~~and labelled~~	B1	
(ii) ~~r = 4 cm~~ r = 40m	B1	Can be implied in the formular.
Area of region R		
$= \frac{90}{360} \times 3.142 \times 4^2 - \frac{1}{2} \times 4 \times 4$	M1	
= ~~12.568 – 8~~ 1256·8 − 800	A1	
= ~~4.568cm²~~ 456·8m²		
~~If~~	10	

121/2 MS If the students works in cm, the marking will be B_{10} M_1, A_0.
If he converts back to m^2, B_1, M_1 A_1

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20. (a)(i) Distance in nm

= 24×90

= 2160 nm → B1

(a)(ii) Distance Km

= 2160 × 1.853

= 4002.48 km → B1

CAD

(b) Position of R

12 = 60 cos10 nm = 2160 B1 60 cos 10° seen

$\theta = \angle PO_1R$ M1 for expression

$\theta = \frac{2160}{60\cos 10}$ → M1 θ subject formula.

= 36.56° in km (36.55), (36.54) A0 In km,

6370 cos 10 B1

Position of R = (10°S, (40 + 36.56)°E) → M1

= (10°S, 76.56°E) ≡ (10°S, 76.55°E) A1

(c) Local time at R

Longitude difference between P and R = 36.56

Time difference = $\frac{36.56 \times 4}{60}$ → M1 Time diff in hrs.

A0

=2hrs 26mins

Local time at R

= 1100h + 2h 26min → M1

= 1326h or

= 1.26 pm → A1 (Units must be specified).

10

If wrong value of θ is used, A_0.

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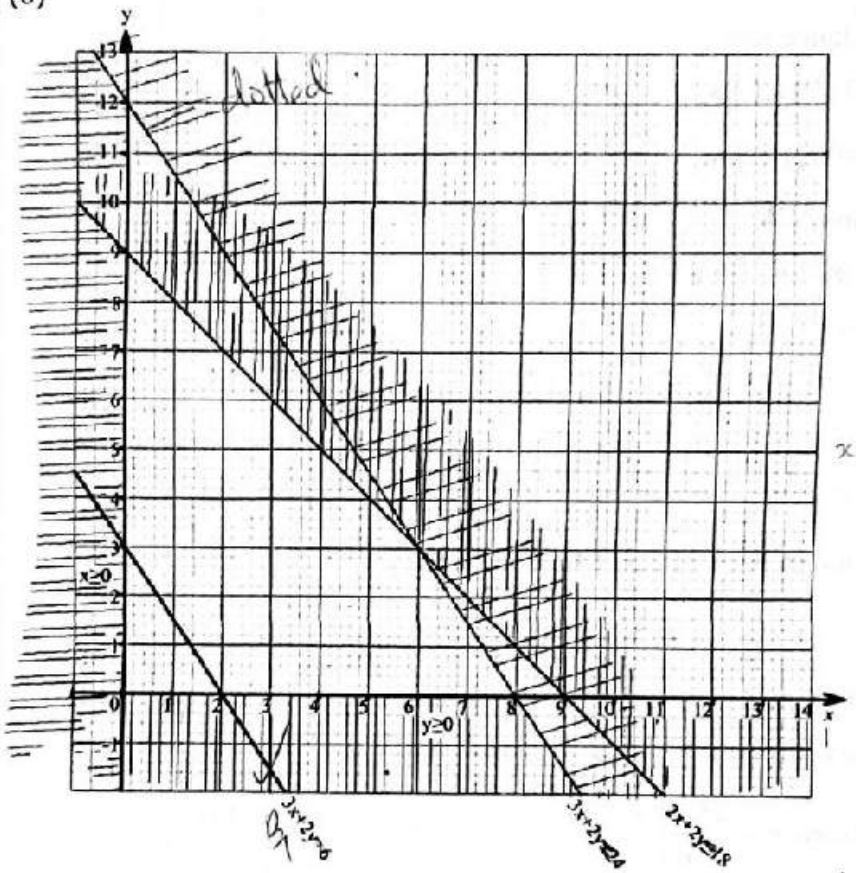
21. (a)

$x \geq 0, \quad y \geq 0$ ✓ B1

$2x + 2y \leq 18$ or $x + y \leq 9$ ✓ B1

$3x + 2y < 24$ ✓ B1

(b)



$x, y \geq 0$

B1 Line & ✓ shading

$x + y \leq 9$

B1 Line & ✓ shading

B1 Line & ✓ shading

$3x + 2y < 24$

(c) (c) Objective function

$6000x + 4000y = P$

$6000x + 4000y = 12000$ *or* $3x + 2y = 6$

$x = 5, y = 4$ ✓ P_2

Profit = sh $(6000 \times 5 + 4000 \times 4)$ ✓ M_1

= sh ~~37000~~ 46,000 ✓ A_1

B1 – Searchline drawn.

B1 – Isolated point.

M1 Or two feasible

A1 points inspected (atleast 2 points inspected)

10

121/2 MS

B_1 for inspected points (atleast 2 points $(5,4), (7,1)$}

B_1 for isolating the points, $x = 5, y = 4$ or $x = 7, y = 1$. 12

$P = 6000 \times 7 + 4000 \times 1$ ✓ M_1

= ~~37000~~ 46,000 ✓ A_1

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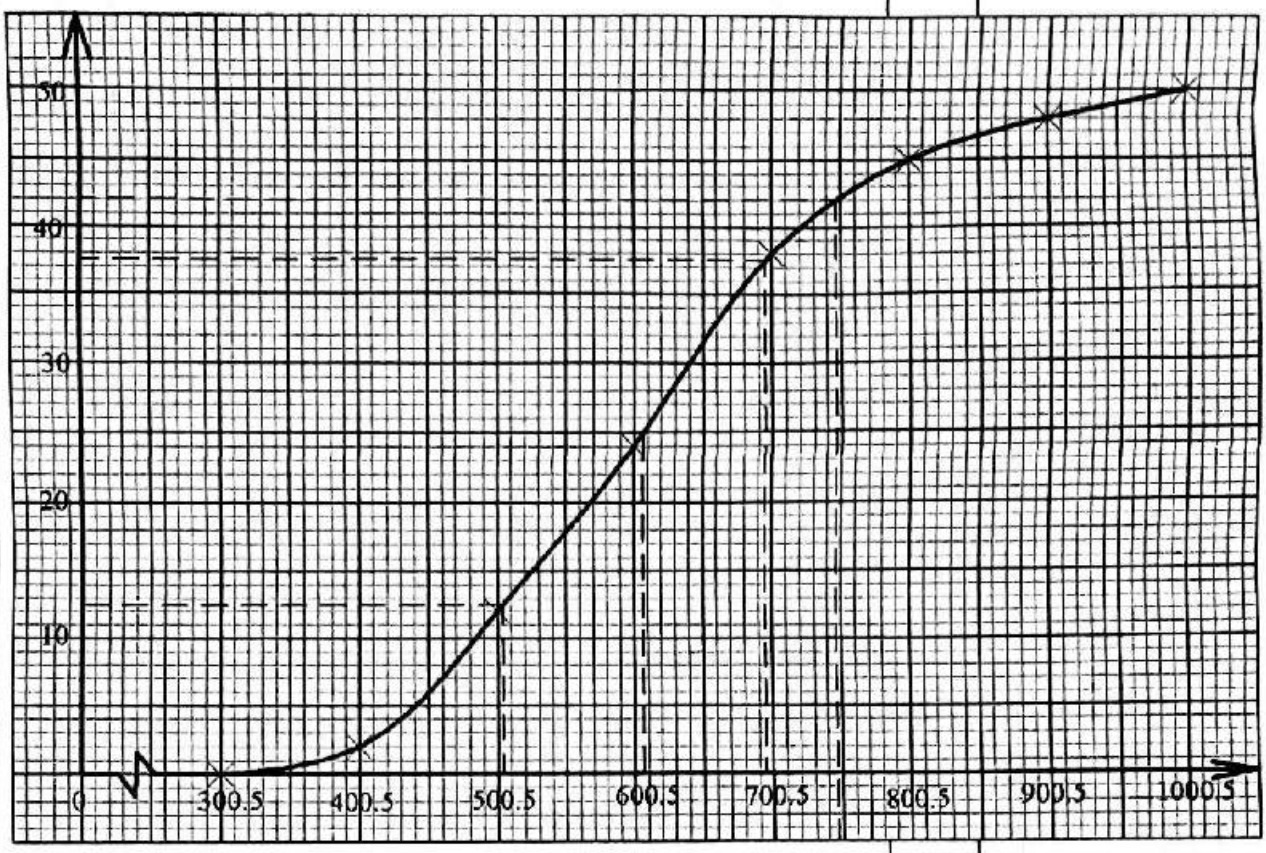
22.



(a) c.f. 2, 12, 24, 38, 45, 48, 50 → B1

S1
P1
C1 — linear & sufficient

(b) (i) Median = Contribution of 25th student

= 605.5 → B_1 — Use student's reading.

(b) (ii) Quartile deviation

Q_3 = Contribution of 37.5 student
= 695.5

Q_1 = Contribution of 12.5 student
= 505.5

→ B1

$\frac{Q_3 - Q_1}{2} = \frac{695.5 - 505.5}{2}$ → M1 — Allow if 1 of Q_s ✓

= 95 → A1

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(b) (iii) No of ~~people~~ students who contributed ~~more than~~ at least 750·50

$= 9 \quad \frac{(50-42)+1}{50} \times 100$ → M1

$\% = \frac{9}{50} \times 100$

$= 18\%$ → A1

10

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23. (a)

(i) $\mathbf{BA} = \mathbf{a} - \mathbf{b}$ OR $-\underset{\sim}{b} - \underset{\sim}{a}$. ✓1 → B1

(ii) $\mathbf{OY} = \frac{3}{4}\mathbf{b} + \frac{1}{4}\mathbf{a}$ ✓1 ✓1 → M1 A1

$\underset{\sim}{OY} = \underset{\sim}{b} + \frac{1}{4}(-\underset{\sim}{b} + \underset{\sim}{a})$ – M1

$= \frac{3}{4}\underset{\sim}{b} + \frac{1}{4}\underset{\sim}{a}$

(iii) $\mathbf{BX} = -\mathbf{b} + \frac{1}{2}\mathbf{a}$ → B1

(b)

$\mathbf{OC} = h\left(\frac{1}{4}\mathbf{a} + \frac{3}{4}\mathbf{b}\right)$ (*i*)

$\mathbf{OC} = \mathbf{b} + k\left(\frac{1}{2}\mathbf{a} - \mathbf{b}\right)$ (*ii*)

→ B1 ✓OC expressed or twice. equivalent

$h\left(\frac{1}{4}\mathbf{a} + \frac{3}{4}\mathbf{b}\right) = \mathbf{b} + k\left(\frac{1}{2}\mathbf{a} - \mathbf{b}\right)$ M1 Equating 2 ✓ OCs eqns, expanded and b factored out.

$\frac{1}{4}h\mathbf{a} + \frac{3}{4}h\mathbf{b} = \frac{1}{2}k\mathbf{a} + (1-k)\mathbf{b}$ → M_1

← ignore

$\frac{1}{4}h = \frac{1}{2}k \Rightarrow \{h = 2k\}$ (*iii*)

$\frac{3}{4}h = 1-k$ (*iv*)

→ M1 Extracting both expressions in h & k

$\frac{3}{4}(2k) = 1-k$ → M1 Attempt to solve simultaneous eqn.

$10k = 4$

$k = \frac{2}{5}$ → A1

$h = \frac{4}{5}$ → B1

10

OW – 1 (vector sign missing applied once).

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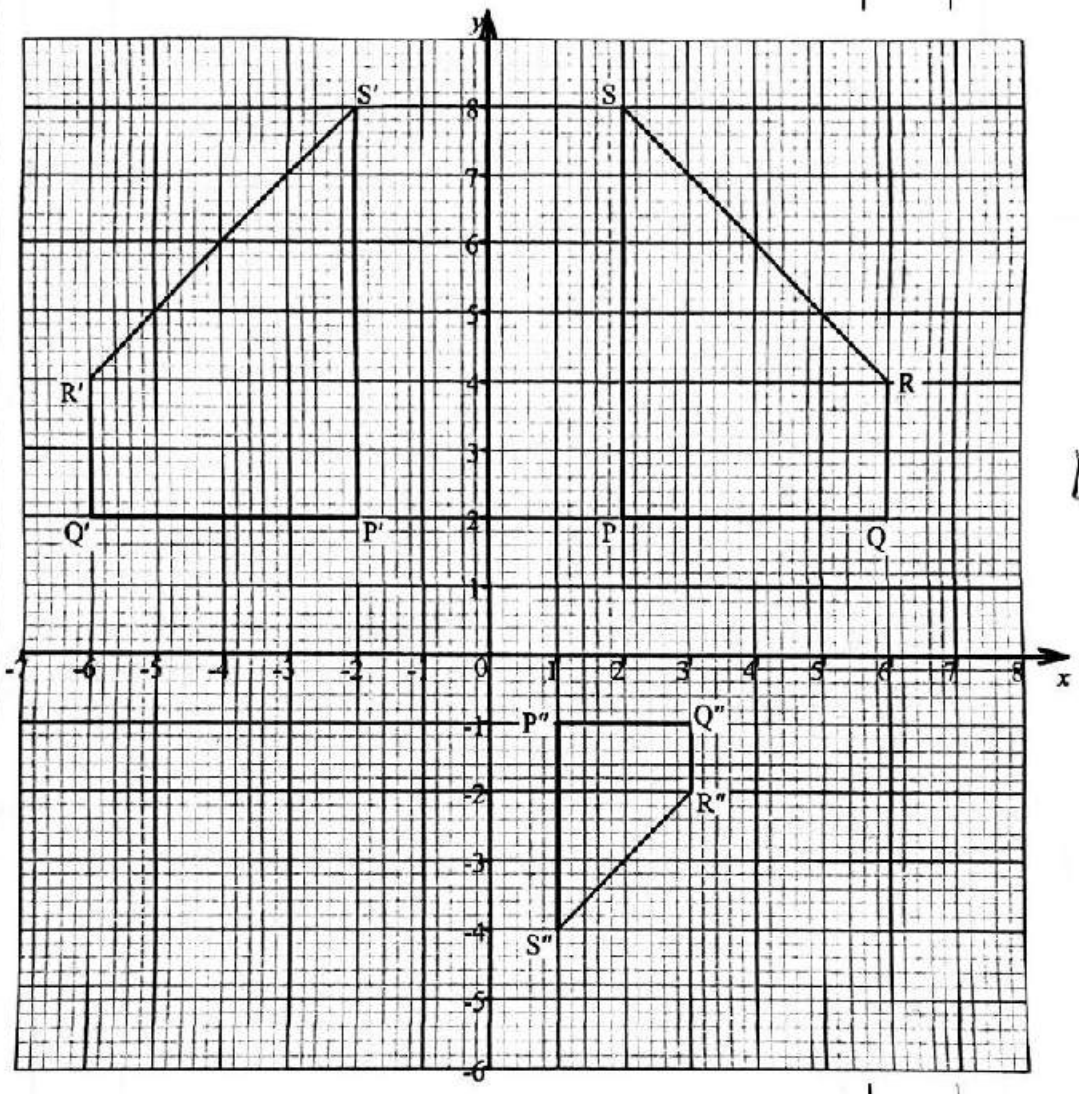
24. (a)

$$\begin{matrix} & P & Q & R & S & & P' & Q' & R' & S' \end{matrix}$$
$$\begin{pmatrix} -1 & 0 \\ 0 & 1 \end{pmatrix}\begin{pmatrix} 2 & 6 & 6 & 2 \\ 2 & 2 & 4 & 8 \end{pmatrix} = \begin{pmatrix} -2 & -6 & -6 & -2 \\ 2 & 2 & 4 & 8 \end{pmatrix}$$

M_1 Correct attempt to pre multiply matrix with object. If no working, M1 can be implied.

Coordinates:

$P'(-2, 2), Q'(-6, 2), R'(-6, 4), S'(-2, 8)$ — A1



B_1 (PQRS labeled)

B_1 (P'Q'R'S' ")

B_1 (P"Q"R"S" & labeled)

(b) Trapezium PQRS correctly drawn and labeled — B1

Trapezium P'Q'R'S' correctly drawn and labeled. — B1

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(c) (i)

$$\begin{matrix} & P & Q & R & S & & P'' & Q'' & R'' & S'' \end{matrix}$$

$$\begin{pmatrix} -\frac{1}{2} & 0 \\ 0 & -\frac{1}{2} \end{pmatrix}\begin{pmatrix} -2 & -6 & -6 & -2 \\ 2 & 2 & 4 & 8 \end{pmatrix} = \begin{pmatrix} 1 & 3 & 3 & 1 \\ -1 & -1 & -2 & -4 \end{pmatrix}$$

B1

B1

(c) (ii) Trapezium P″Q″R″S″ correctly drawn

(d) (i) The matrix is N^{-1}

$$\text{Det} = -\frac{1}{2}\times-\frac{1}{2} - 0\times0$$

$$= \frac{1}{4}$$

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

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

forming eqns and ✓ attempt to solve one pair

finding inverse

M1

✓ Process of getting N^{-1}

A1

(even if matrix is stated)

(d)(ii) Enlargement centre O(0, 0)

B1

S.F = -2

B1

10