KCSE 2024

MATHS PAPER 2

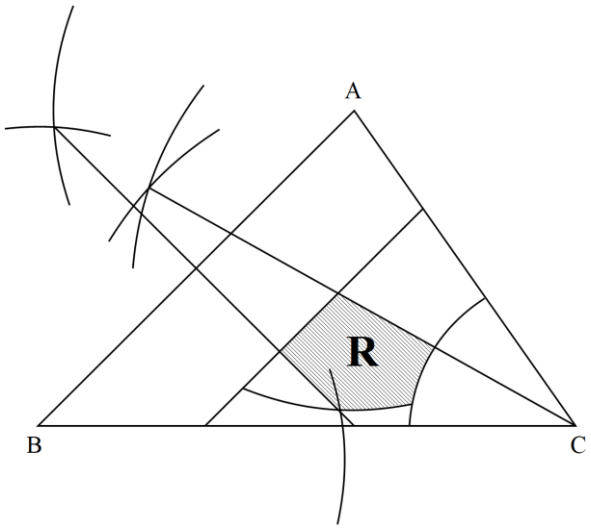
MARKING SCHEME

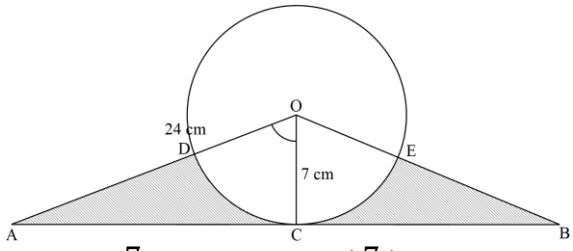
NO.	WORKING	MARKS	REMARKS
1.	$x+4=0$ $x-\frac{2}{3}=0 \rightarrow 3x-2=0$ $(x+4)(3x-2)=0$ $x(3x-2)+4(3x-2)=0$ $3x^2-2x+12x-8=0$ $3x^2+10x-8=0$	 M1 M1 A1	 Factorization by grouping Expansion $3x^2+10x-8=0$ seen
	Total	**3**	
2.	$\max\left(\frac{p-q}{q+p}\right)=\frac{\max(p-q)}{\min(q+p)}=\frac{\max p-\min q}{\min q+\min p}$ $\frac{\max p-\min q}{\min q+\min p}=\frac{8-3}{3+2}$ $=5$	 M1 A1	
	Total	**2**	
3.	$\frac{2}{1+\sqrt{3}}$ $\frac{2(1-\sqrt{3})}{(1+\sqrt{3})(1-\sqrt{3})}$ $\frac{2-2\sqrt{3}}{1-(\sqrt{3})^2}=\frac{2-2\sqrt{3}}{1-3}=\frac{2-2\sqrt{3}}{-2}=\sqrt{3}-1$	B1 M1 A1	Identifying $\sin 90^0$ and $\tan 60^0$ in terms of numbers Multiplying by $1-\sqrt{3}$ $\sqrt{3}-1$ seen
	Total	**3**	
4.	$\log_2(8-x)-\log_2(x-3)=2\log_2 2$ $\log_2(8-x)-\log_2(x-3)=\log_2 2^2$ $\log_2\left(\frac{8-x}{x-3}\right)=\log_2 4$ $\frac{8-x}{x-3}=4$ $4(8-x)=x-3$ $32-4x=x-3$ $32+3=x+4x \rightarrow 5x=35$ $x=7$	M1 M1 A1	Write 2 as $2\log_2 2$
	Total	**3**	

5.	$\text{Amount} = 1{,}800{,}000\left(1-\frac{10}{100}\right)^2$ $= 1{,}458{,}000$ $\text{Amount} = 1{,}458{,}000\left(1-\frac{15}{100}\right)^3$ $895{,}394.25$	M1 M1 A1	
	Total	**3**	

NO.	WORKING	MARKS	REMARKS
6.	$\boldsymbol{AB} = \boldsymbol{OB} - \boldsymbol{OA} = \begin{pmatrix}-2\\3\\8\end{pmatrix} - \begin{pmatrix}4\\-5\\6\end{pmatrix} = \begin{pmatrix}-6\\8\\2\end{pmatrix}$ $\lvert\boldsymbol{AB}\rvert = \sqrt{(-6)^2+8^2+2^2}$ $= \sqrt{104}$ $= 10.198$ units	B1 M1 A1	$\boldsymbol{AB} = -6\boldsymbol{i} + 8\boldsymbol{j} - 2\boldsymbol{k}$ or equivalent in column form seen 10.198 seen
	Total	**3**	
7.	$\frac{1}{2} \times v(26+45) = 852$ $v(71) = 852$ $v = \frac{852}{17} = 24$ m/s	M1 A1	
	Total	**2**	
8.	$(px)^2 = x^2 + \frac{m}{Q}$ $p^2x^2 - x^2 = \frac{m}{Q}$ $x^2(p^2-1) = \frac{m}{Q}$ $x^2 = \frac{m}{Q} \times \frac{1}{p^2-1}$ $x = \pm\sqrt{\frac{m}{Q(p^2-1)}}$	M1 M1 A1	
	Total	**3**	
9.	$x^2 + 6x + 3^2 + y^2 - 10y + (-5)^2$ $= 2 + 3^2 + (-5)^2$ $(x+3)^2 + (y-5)^2 = 36$ $(x+3)^2 + (y-5)^2 = 6^2$ Centre→ $(-3,\ 5)$ Radius = 6 units→ Area = $\pi \times 6 \times 6 = 36\pi$	 B1 B1 B1	 Equation of the circle in the form $(x-a)^2 + (y-b)^2 = r^2$ Centre $(-3,\ 5)$ seen 36π seen
	Total	**3**	
10.	(a) Binomial co-efficients $1, 6, 15, 20, \ldots$		

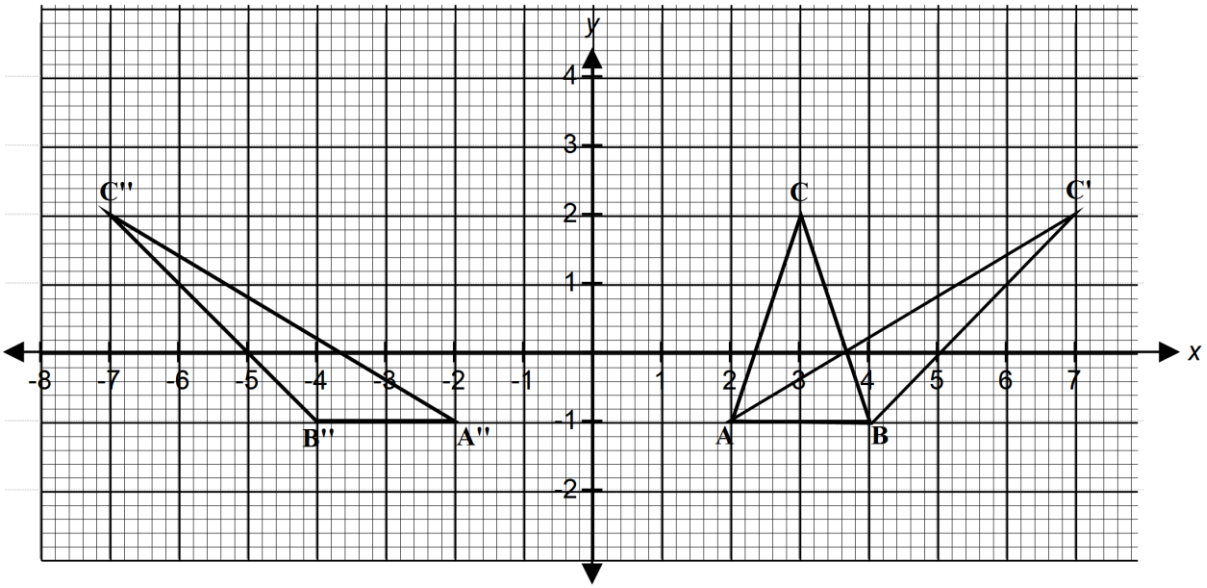
	$(1+3x)^6 = 1 + 6(3x) + 15(3x)^2 + 20(3x)^3 + \cdots$ $(1+3x)^6 = 1 + 18x + 135x^2 + 540x^3 + \cdots$ (b) $1 + 3x = 0.0997 \rightarrow 3x = 0.997 - 1 = -0.003$ $x = -0.001$ $(0.997)^6 = 1 + 18(-0.001) + 135(-0.001)^2 + 540(-0.001)^3 + \cdots$ $(0.997)^6 = 0.98213446$ $= 0.98213$	M1 M1 A1	
	Total	**3**	

NO.	WORKING	MARKS	REMARKS
11.	<table><tr><td>y</td><td>1</td><td>1.5</td><td>2</td><td>2.5</td><td>3</td><td>3.5</td><td>4</td><td>4.5</td><td>5</td></tr><tr><td>x</td><td>2</td><td>**1.25**</td><td>**1**</td><td>**1.25**</td><td>2</td><td>**3.25**</td><td>5</td><td>**7.25**</td><td>**10**</td></tr></table> $h = \frac{5-1}{4} = 1$ Area $= 1(1.25 + 1.25 + 3.25 + 7.25)$ $=$ 13 square units	B1 M1 A1	Missing values of y all correct
	Total	**3**	
12.	Change in longitude$= 10^0 + 50^0 = 60^0$ $RT = \frac{60}{360} \times 2 \times \frac{22}{7} \times 6370 \cos 37^0$ $=$ 5,329.56097 km	B1 M1 A1	
	Total	**3**	
13.		B1 B1 B1 B1 B1	Bisecting line AB Parallel line 2cm away from AB Bisecting angle at C Arc radius 1.5 cm and centre C

			R shaded and labeled
	Total	**5**	
14.	 $\cos\theta = \frac{7}{24} \rightarrow \theta = \cos^{-1}\left(\frac{7}{24}\right) = 73.04^0$ $\angle AOB = 2 \times 73.04^0 = 146.08^0$ Area of $\Delta AOB = \frac{1}{2} \times 24 \times 24 \times \sin 146.08^0$ $= 160.7140\ \text{cm}^2$ Area of sector $= \frac{146.08^0}{360} \times \frac{22}{7} \times 7 \times 7$ $= 62.4898\ \text{cm}^2$ Shaded Area $= 160.7140 - 62.4898$ $= 98.2242$ $= 98.22\ \text{cm}^2$ (4 significant figures)	B1 M1 M1 A1	
	Total	**4**	
NO.	**WORKING**	**MARKS**	**REMARKS**
15.	$300x + 700y \leq 21{,}000$ $x + y > 20$ $x < 2y$ $x > 15$	B1 B1 B1 B1	
	Total	**4**	
16.	P and Q in 1 day $\rightarrow \frac{1}{4} + \frac{1}{6}$ $= \frac{5}{12}$ P and Q in 2 days $\rightarrow 2 \times \frac{5}{12} = \frac{5}{6}$ Remainder $= 1 - \frac{5}{6} = \frac{1}{6}$ Q does $\frac{1}{6}$ in 1 day	M1 M1 A1	Work done by P and Q together in 1 day Work done by P and Q together in 2 days
	Total	**3**	

NO.	**WORKING**	**MARKS**	**REMARKS**
17.	(a) $\begin{pmatrix} 1 & 2 \\ 0 & 1 \end{pmatrix}\begin{pmatrix} 2 & 4 & 3 \\ -1 & -1 & 2 \end{pmatrix} = \begin{pmatrix} 0 & 2 & 7 \\ -1 & -1 & 2 \end{pmatrix}$ $A'(0,-1), B'(2,-1), C'(7,2)$ (b) $A'B'C'$ drawn	M1 A1 B1	

	Shear; line $x = -1$ invariant, $C(3,2)$ mapped onto $C'(7,2)$ (c) $\Delta A''B''C''$ drawn $A''(-2,-1), B''(-4,-1)$ and $C''(-7,2)$ (d) Let the matrix be $\begin{pmatrix} p & q \\ r & s \end{pmatrix}$ $\begin{pmatrix} p & q \\ r & s \end{pmatrix}\begin{pmatrix} 2 & 4 & 3 \\ -1 & -1 & 2 \end{pmatrix} = \begin{pmatrix} -2 & -4 & -7 \\ -1 & -1 & 2 \end{pmatrix}$ $\begin{pmatrix} 2p-q & 4p-q & 3p+2q \\ 2r-s & 4r-s & 3r+2s \end{pmatrix} = \begin{pmatrix} -2 & -4 & -7 \\ -1 & -1 & 2 \end{pmatrix}$ $2p - q = -2 \ldots \times 2$ $3p + 2q = -7$ $\underline{4p - 2q = -4}$ $7p = -11 \rightarrow p = \frac{-11}{7}$	B1, B1 B1 B1	
	Total	**10**	



NO.	WORKING	MARKS	REMARKS
18.	(a) $T_1 = 5 \times 1 - 3 = 3$ $T_2 = 5 \times 2 - 2 = 8$ $T_3 = 5 \times 3 - 2 = 13$ (b) $T_3 = ar^{3-1} = ar^2 = 18$ $T_6 = ar^{6-1} = ar^5 = 486$ $\frac{ar^5}{ar^2} = \frac{486}{18}$ $r^3 = 27$	B1 M1	All first 3 terms correct

	$r = \sqrt[3]{27} = 3$	M1, A1	Ratio of 6th to 3rd terms
	(c) Number of terms		
	$-3094 = \frac{n}{2}(8 + (-190))$	M1	Taking $\sqrt[3]{27}$, 3 seen
	$-3094 \times 2 = n(8 - 190)$		
	$n = \frac{-3094 \times 2}{(8 - 190)}$		
	$n = 34$	A1	
	(d) $T_2 = a + d, T_4 = a + 3d, T_7 = a + 6d$		
	$2 + d, 2 + 3d, 2 + 6d, \ldots$		
	$\frac{2 + 6d}{2 + 3d} = \frac{2 + 3d}{2 + d}$	M1	
	$(2 + 6d)(2 + d) = (2 + 3d)(2 + 3d)$		
	$2(2 + d) + 6d(2 + d)$ $= 2(2 + 3d) + 3d(2 + 3d)$		Expression for common ratio
	$4 + 14d + 6d^2 = 4 + 12d + 9d^2$		
	$14d - 12d = 9d^2 - 6d^2$		
	$2d = 3d^2 \rightarrow 2 = 3d$	M1	
	$d = \frac{2}{3}$	A1	
	$r = \frac{2 + 6 \times \frac{2}{3}}{2 + 3 \times \frac{2}{3}} = \frac{3}{2} = 1\frac{1}{2}$ or 1.5	B1	Simplification $\frac{2}{3}$ seen 1.5 seen
	Total	**10**	

NO.	WORKING	MARKS	REMARKS
19.	(a) (i) Relationship		
	$P = kQ^2 + \frac{c}{\sqrt{R}}$		
	$11\frac{1}{3} = 4k + \frac{c}{\sqrt{9}} \rightarrow \frac{34}{3} = 4k + \frac{c}{3} \rightarrow 34$ $= 12k + c \ldots (i)$	M1	Forming 2 equations in k and c
	$14\frac{3}{4} = 5k + \frac{c}{\sqrt{64}} \rightarrow \frac{59}{4} = 5k + \frac{c}{8} \rightarrow 118$ $= 40k + c \ldots (ii)$		
	$12k + c = 34$	M1	
	$\underline{40k + c = 118}$		Correct attempt to solve the equations simultaneously
	$-28k = -84$		
	$k = \frac{-84}{-28} = 3$	A1	
	$12 \times 3 + c = 34 \rightarrow c = 34 - 12 \times 3$		
	$c = -2$		Values of k and c
	Hence	B1	

	$P = 3Q^2 - \frac{2}{\sqrt{R}}$ (ii) Q when $P = 145\frac{11}{18}$ and $R = 1.44$ $P = 3Q^2 - \frac{2}{\sqrt{R}} \rightarrow 145\frac{11}{18} = 3Q^2 - \frac{2}{\sqrt{1.44}}$ $3Q^2 = 145\frac{11}{18} + \frac{2}{1.2}$ $3Q^2 = \frac{2651}{18}$ $Q^2 = \frac{2651}{18} \times \frac{1}{3} = \frac{2651}{54}$ $Q = \sqrt{\frac{2651}{54}} = 7.007$ (b) A, B, C and D $A \propto \frac{kB\sqrt{C}}{D^2} \rightarrow A = \frac{kB\sqrt{C}}{D^2}$ $B_1 = 1.21B,\ C_1 = \sqrt{0.64C} = 0.8\sqrt{C}$ and $D_1 = (1.1D)^2 = 1.21D^2$ $A_1 = \frac{k(1.21B)0.8\sqrt{C}}{1.21D^2} = \frac{1.21 \times 0.8}{1.21}\left(\frac{kB\sqrt{C}}{D^2}\right)$ $A_1 = 0.8A$ Percentage change in A $= \frac{0.8 - 1}{1} \times 100$ $= -20\%$ A decrease of 20%	M1 M1 M1 M1 A1	Relationship between P, Q and R Values of B_1, C_1 and D_1 in terms of B, C and D Expression for A_1 A0 if left as -20%
	Total	**10**	

NO.	WORKING	MARKS	REMARKS
20.	(a) $S = 5^3 - 5 \times 5^2 + 4$ $S = 4$ metres (b) Velocity at $t = 5$ $\frac{dS}{dt} = 3t^2 - 10t$ $v = 3 \times 5^2 - 10 \times 5$ $v = 75 - 50 = 25$ m/s	M1 A1 M1 M1 A1	 Differentiation Substitution

	(c) Time at $v = 0$ $3t^2 - 10t = 0$ $t(3t - 10) = 0$ $t = 0$ $3t = 10 \rightarrow t = 3\frac{1}{3}$ Hence $t = 3\frac{1}{3}$ seconds (d) a at $t = 2$ $\frac{dv}{dt} = 6t - 10$ $a = 6 \times 2 - 10 = 2\ \text{m/s}^2$	M1 A1 B1 M1 A1	Equation v to 0 Both values of t $t = 0$ discriminated Differentiating v
	Total	**10**	
21.	(a) $\text{VN} = \sqrt{12^2 - 7.5^2}$ $\text{VN} = \sqrt{87.75} = 9.367$ cm $\text{VO} = \sqrt{9.367^2 - 4^2}$ $\text{VO} = 8.46998 \cong 8.47$ (2 decimal places) (b) Volume of pyramid $\text{Volume} = \frac{1}{3} \times 8 \times 15 \times 8.47 = 338.80$ (c) Consider ΔVMN where M is the midpoint of AD $8^2 = 2 \times 9.367^2 - 2 \times 9.367^2 \cos \text{V}$ $\frac{8^2 - 2 \times 9.367^2}{-2 \times 9.367^2} = \cos \text{V}$ $\cos \text{V} = 0.63529$ $\text{V} = \cos^{-1}(0.63529) = 50.56^0$ Obtuse $\angle\text{VMN} = 180^0 - 50.56^0 = 129.44^0$ (d) Consider ΔVDO $\sin\theta = \frac{8.47}{12}$ $\theta = \sin^{-1}\left(\frac{8.47}{12}\right) = 44.90^0$	M1 M1 A1 B1 M1 M1 A1 B1 M1 A1	
	Total	**10**	

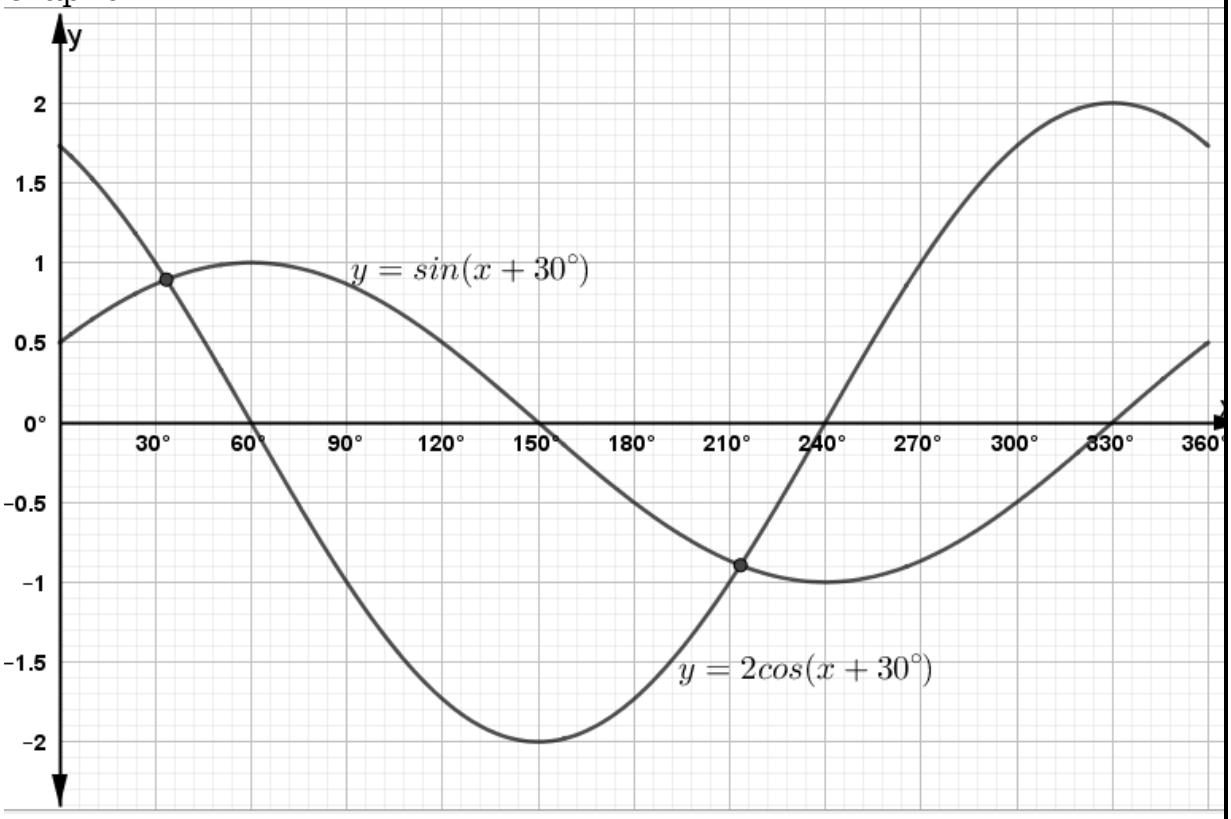
NO.	WORKING	MARKS	REMARKS
22.	(a) Table Values		

x	0^0	30^0	60^0	90^0	120^0	150^0	180^0	210^0	240^0	270^0	300^0	330^0	360^0

$y = \sin(x + 30^0)$	**0.50**	0.87	1	**0.87**	0.87	**0.00**	-0.5	**-0.87**	-1.00	-0.87	**-0.50**	0.00	**0.50**
$y = 2\cos(x + 30^0)$	**1.73**	1.00	**0.00**	-1.00	**-1.73**	-2.00	**-1.73**	-1.00	**0.00**	1.00	1.73	**2.00**	**1.73**

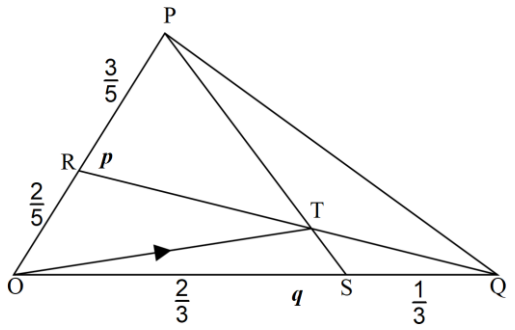
B2 – all table values correct (B1 for at least 10 table values correct)

(b) Graphs



S1 – given scales used
P1 – plotting $y = \sin(x + 30^0)$
C1 – drawing $y = \sin(x + 30^0)$
P1 – plotting $y = 2\cos(x + 30^0)$
C1 – drawing $y = 2\cos(x + 30^0)$

	(c) $x = 36^0$ and $x = 216^0 \pm 6^0$	B1	
	(d) 2	B1	
	Total	**10**	

NO.	WORKING	MARKS	REMARKS
23.			
	(a) (i) $\boldsymbol{QR} = \boldsymbol{QO} + \boldsymbol{OR}$ $\boldsymbol{QR} = -\boldsymbol{q} + \frac{2}{5}\boldsymbol{p}$	B1	$\boldsymbol{QR}$
	(ii) $\boldsymbol{PS} = \boldsymbol{PO} + \boldsymbol{OS}$ $\boldsymbol{PS} = -\boldsymbol{p} + \frac{2}{3}\boldsymbol{q}$	B1	$\boldsymbol{PS}$
	(b) (i) $\boldsymbol{QT} = h\boldsymbol{QR} \rightarrow \boldsymbol{QT} = h\left(-\boldsymbol{q} + \frac{2}{5}\boldsymbol{p}\right)$ $\boldsymbol{QT} = \frac{2h}{5}\boldsymbol{p} - h\boldsymbol{q}$ Also	B1	
	$\boldsymbol{PT} = k\boldsymbol{PS} \rightarrow \boldsymbol{PT} = k\left(-\boldsymbol{p} + \frac{2}{3}\boldsymbol{q}\right)$ $\boldsymbol{PT} = \frac{2k}{3}\boldsymbol{q} - k\boldsymbol{p}$	B1	
	(ii) $\boldsymbol{OT} = \boldsymbol{OQ} + \boldsymbol{QT} = \boldsymbol{q} - h\boldsymbol{q} + \frac{2h}{5}\boldsymbol{p}$ $\boldsymbol{OT} = (1-h)\boldsymbol{q} + \frac{2h}{5}\boldsymbol{p}$ Also	B1	
	$\boldsymbol{OT} = \boldsymbol{OP} + \boldsymbol{PT} \rightarrow \boldsymbol{p} - k\boldsymbol{p} + \frac{2k}{3}\boldsymbol{q}$ $\boldsymbol{OT} = (1-k)\boldsymbol{p} + \frac{2k}{3}\boldsymbol{q}$	B1	
	(c) h and k $\frac{2h}{5} = 1 - k \rightarrow 2h + 5k = 5 \ldots (i) \times 3$ $1 - h = \frac{2k}{3} \rightarrow 3h + 2k = 3 \ldots (ii) \times 2$ $6h + 15k = 15$ $\underline{6h + 4k = 6}$ $11k = 9 \rightarrow k = \frac{9}{11}$	M1 M1 A1	Comparing coefficients of $\boldsymbol{p}$ and $\boldsymbol{q}$ Correct attempt to solve the two equations Value of k
	$2h + 5 \times \frac{9}{11} = 5$ $2h = 5 - \frac{45}{11}$ $2h = \frac{10}{11} \rightarrow h = \frac{10}{11} \div 2 = \frac{5}{11}$	B1	Value of h
	Total	**10**	

NO.	WORKING	MARKS	REMARKS
24.	Frequency Table $A = 73$		

Marks	f	x	$d = x - A$	fd	d^2	fd^2	cf	U.C.B
61 – 65	4	63	-10	-40	100	400	4	65.5
66 – 70	5	68	-5	-25	25	125	9	70.5
71 – 75	9	73	0	0	0	0	18	75.5
76 – 80	8	78	5	40	25	200	26	80.5
81 – 85	8	83	10	80	100	800	34	85.5
86 – 90	6	88	15	90	225	1350	40	90.5
	40			**145**		**2875**		

All d correct – B1

All fd correct – B1

(a) (i) Mean

$$\text{Mean } (\bar{x}) = A + \frac{\sum fd}{\sum f} = 73 + \frac{145}{40} - \text{M1}$$

Mean $= 76.625$ – A1

(ii) Standard Deviation

$$s = \sqrt{\frac{\sum fd}{f} - \left(\frac{\sum fd}{\sum f}\right)^2}$$

$$s = \sqrt{\frac{2875}{40} - \left(\frac{145}{40}\right)^2}$$

$s = 7.664$

(b) (i) Ogive

(ii) 25th Student

	Total	**10**	