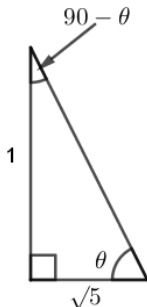


TERM 2 – 2022
MATHEMATICS FORM 4 PAPER 2
(121/2) MARKING SCHEME

NO.	WORKING	MARKS	REMARKS
1.	$(\log_{10} x)^2 = 3 - 2\log_{10} x$ Let $\log_{10} x = t$ $t^2 = 3 - 2t$ $t^2 + 2t - 3 = 0$ $t = \frac{-2 \pm \sqrt{2^2 - 4 \times 1 \times -3}}{2}$ $t = \frac{-2 \pm \sqrt{16}}{2} \rightarrow t = \frac{-2 \pm 4}{2}$ Either $t = \frac{-2 + 4}{2} = 1$ Or $t = \frac{-2 - 4}{2} = -3$ $\rightarrow \log_{10} x = 1 \rightarrow x = 10^1 \rightarrow x = 1$ Also $\log_{10} x = -3 \rightarrow x = 10^{-3} \rightarrow x = \frac{1}{10^3} = \frac{1}{1000}$	M1 M1 A1 B1	Forming and ✓ attempt to solve quadratic equation. Square root of 16, or factorization by grouping or adding c in completing square Both values of t Both values of x
	Total	4	
2.	Max Area = $\frac{1}{2} \times 4.15 \times 5.05 = 10.47875$ Min Area = $\frac{1}{2} \times 4.05 \times 4.95 = 10.02375$ Absolute Error = $\frac{10.47875 - 10.02375}{2} = 0.2275$ Percentage Error = $\frac{0.2275}{\frac{1}{2} \times 4.1 \times 5.0} \times 100$ = 2.220%	M1 M1 A1	Expression for absolute error in area Expression for percentage error
	Total	3	
3.	 hyp = $\sqrt{1^2 + (\sqrt{5})^2} = \sqrt{6}$ $\sin(90 - \theta) = \frac{\sqrt{5}}{\sqrt{6}}$ $\frac{\sqrt{5} \times \sqrt{6}}{\sqrt{6} \times \sqrt{6}} = \frac{\sqrt{30}}{6}$	M1 A1	Expression for $\sin(90 - \theta)$

			Simplified
	Total	2	
NO.	WORKING	MARKS	REMARKS
4.	$A = 200\,000 \left(1 + \frac{14}{100 \times 2}\right)^{2 \times 2}$ $A = 200\,000 \left(1 + \frac{14}{200}\right)^4$ $A = 262\,159.20$ $\text{Interest} = 262\,159.20 - 200\,000$ $= 62\,159.20$	M1 M1 A1	
	Total	3	
5.	$S^2 = \frac{d^2 v^2}{c v^2 - f}$ $c S^2 v^2 - f S^2 = d^2 v^2$ $c S^2 v^2 - d^2 v^2 = f S^2$ $v^2 (c S^2 - d^2) = f S^2$ $v^2 = \frac{f S^2}{c S^2 - d^2}$ $v = \pm \sqrt{\frac{f S^2}{c S^2 - d^2}}$	M1 M1 A1	Removing square root/squaring both sides Collecting terms with v^2 A0 if \pm is missing from the accuracy
	Total	3	
6.	Sellin price without profit $125\% \rightarrow 120$ $100\% \rightarrow \frac{100 \times 120}{125}$ $= \text{Ksh } 96$ Let the ratio be $x:y$ $\frac{80x + 100y}{x + y} = 96$ $80x + 100y = 96x + 96y$ $100y - 96y = 96x - 80x$ $4y = 16x \rightarrow y = 4x$ $\frac{x}{y} = \frac{1}{4} \rightarrow x:y = 1:4$	M1 M1 A1	Expression for selling price at 100%
	Total	3	
7.	$6x + 12y \leq 80$ $2x + \frac{3}{4}y \leq 12$ $x > 0, y > 0$	B1 B1 B1	Accept the inequalities if simplified Both
	Total	3	
8.	$x^2 + 2x + y^2 - 4y = 4$ $x^2 + 2x + 1 + y^2 - 4y + 4 = 4 + 1 + 4$ $(x + 1)^2 + (y - 2)^2 = 9$ $(x + 1)^2 + (y - 2)^2 = 3^2$ Centre $\rightarrow (-1, 2)$ Radius $\rightarrow 3$ units	M1 M1 A1	Completing the square in x and y Equation in the form $(x - a)^2 + (y - b)^2 = r^2$ Both centre and radius
	Total	3	

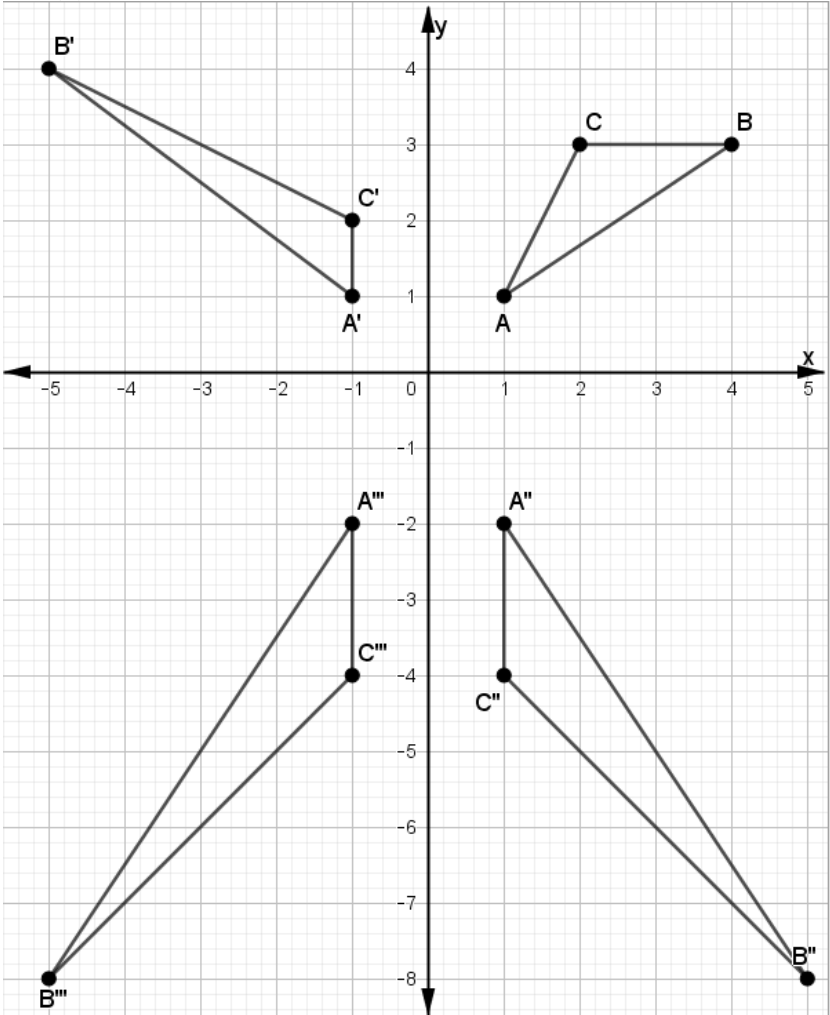
NO.	WORKING	MARKS	REMARKS
9.	(a) Value of b $\frac{360^0}{b} = 120^0 \rightarrow 120b = 360 \rightarrow b = 3$ (b) Phase angle 60^0	B1 B1	
	Total	2	
10.	$2100 = 60\alpha \cos 60^0$ $\alpha = \frac{2100}{60 \cos 60^0}$ $\alpha = 70^0$ Hence P(60^0 N, 70^0 E)	M1 A1 B1	
	Total	3	
11.	$80\ 100 = \frac{n}{2}\{2 \times 200 + (n - 1)500\}$ $160\ 200 = n(400 + 500n - 500)$ $160\ 200 = 400n + 500n^2 - 500n$ $500n^2 - 100n - 160\ 200 = 0$ $5n^2 - n - 1\ 602 = 0$ $n = \frac{-(-1) \pm \sqrt{(-1)^2 - 4 \times 1 \times -1602}}{2 \times 5}$ $n = \frac{1 \pm \sqrt{32041}}{10} = \frac{1 \pm 179}{10}$ Either $n = \frac{1 - 179}{10} = -\frac{89}{5}$ (<i>discriminate</i>) $n = \frac{1 + 179}{10} = 18$ Hence $n = 18$	M1 M1 M1 A1	
	Total	4	
12.	Binomial coefficients 1, 5, 10, 10, ... $(3 - x)^5 = 3^5 - 5(3^4)x + 10(3^3)(x^2) - 10(3^2)(x^3) + \dots$ $= 243 - 405x + 270x^2 - 90x^3 + \dots$ $(3 - x)^5 = \left(3\frac{1}{50}\right)^5 \rightarrow \left(3 + \frac{1}{50}\right)^5 \rightarrow x = -\frac{1}{50} = -0.02$ $\left(3\frac{1}{50}\right)^5 = 243 - 405\left(-\frac{1}{50}\right) + 270\left(-\frac{1}{50}\right)^2 - 90\left(-\frac{1}{50}\right)^3 + \dots$ $= 251.20872 \cong 251.2087$ (4 decimal places)	B1 M1 A1	
	Total	3	

NO.	WORKING	MARKS	REMARKS
13.	$P = \frac{kQ^3}{\sqrt{R}}$ $Q_1 = 0.8Q \text{ and } R_1 = 1.21R$ $P_1 = \frac{kQ_1^3}{\sqrt{R_1}} = \frac{k(0.8Q)^3}{\sqrt{1.21R}}$ $P_1 = \frac{0.512kQ^3}{1.1\sqrt{R}} = \frac{512}{1100}P$ $\% \text{ change} = \frac{\frac{512}{1100}P - P}{P} \times 100$ $= -0.5345\%$ <p>Hence a decrease of 0.5345%</p>	<p>M1</p> <p>M1</p> <p>A1</p>	
	Total	3	
14.	$\frac{1}{2.345^2} = \frac{1}{5.499} = 0.1818$ $\sqrt{0.6789} = \sqrt{67.89 \times 10^{-2}} = 8.2396 \times 10^{-1}$ $= 0.82396$ $0.1818 + 0.82396 = 1.00576$	<p>M1, M1</p> <p>M1</p> <p>A1</p>	<p>5.499 seen, 0.1818 seen</p> <p>0.82396 seen</p>
	Total	4	
15.	$a^2 = 11^2 + 9^2 = 2 \times 11 \times 9 \cos 70^\circ$ $a^2 = 121 + 81 - 198 \times 0.1736$ $a^2 = 167.6272$ $a = \sqrt{167.6272} = 12.947$ $\text{Radius} = \frac{12.947}{2} = 6.4735$ $A = \frac{1}{2} \times 3.142 \times 6.4735^2$ $A = 65.83 \text{ cm}^2 \text{ (2 decimal places)}$	<p>M1</p> <p>M1</p> <p>A1</p>	
	Total	3	
16.	$\frac{(2n-4)90^\circ}{(2(n+3)-4)90^\circ} = \frac{1}{2}$ $\frac{2n-4}{2n+2} = \frac{1}{2} \rightarrow 2(2n-4) = 2n+2$ $4n-8 = 2n+2$ $2n = 10 \rightarrow n = 5$	<p>M1</p> <p>M1</p> <p>A1</p>	
	Total	3	

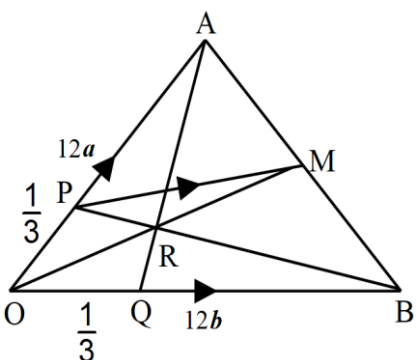
NO.	WORKING	MARKS	REMARKS
17.	<p>(a) Taxable income $35\,500 + 15\,600$ $= 48\,100$</p> <p>(b) PAYE $13\,450 \times \frac{10}{100} = 1\,345$ $(26\,350 - 13\,450) \times \frac{15}{100} = 1\,935$ $(39\,250 - 26\,350) \times \frac{20}{100} = 2\,580$ $(48\,100 - 39\,250) \times \frac{25}{100} = 2\,212.50$ Gross tax = $1\,345 + 1\,935 + 2\,580 + 2\,212.50$ $= 8\,072.50$ PAYE = $8\,072.50 - 1\,845$ $= 6\,227.50$</p> <p>(c) Net Salary Gross Pay = $48\,100 + 5\,872 = 53\,972$</p> <p>Net Pay = $53\,972 - (6\,227.50 + 1\,000 + 455 + 200)$ $= 46\,089.50$</p>	<p>M1 A1</p> <p>M1</p> <p>M1</p> <p>M1</p> <p>M1 A1</p> <p>M1</p> <p>M1 A1</p>	<p>First 3 bands/slabs</p> <p>Last band/slab</p> <p>Gross tax</p> <p>Gross salary</p>
	Total	10	

NO.	WORKING	MARKS	REMARKS
18.		<p>B1</p> <p>B1</p> <p>B1</p> <p>B1</p> <p>B1</p> <p>B1</p> <p>B1</p> <p>B1</p>	<p>120^0 constructed at A and D (B0 if measured)</p> <p>90^0 constructed at E</p> <p>Locating E</p> <p>Completing the polygon</p> <p>$DC = 6.9 \text{ cm} \pm 0.1 \text{ cm}$</p> <p>Bisecting angle DCB</p> <p>Bisecting line DE</p> <p>Arc 6 cm radius, centre A</p> <p>Shading required region</p> <p>Labeling R</p>
Total		10	

NO.	WORKING	MARKS	REMARKS
19.	<p>(a) Tree diagram</p> <p>(b) Probabilities</p> <p>(i) Rains, beats jam, late $P(RJ'L) = 0.8 \times 0.3 \times 0.7 = 0.168$</p> <p>(ii) Arrive on time $P(L') = P(RJL') \text{ or } P(RJ'L') \text{ or } P(R'JL') \text{ or } P(R'J'L')$ $P(RJL') = (0.8 \times 0.7 \times 0.4) = 0.224$ $P(RJ'L') = 0.8 \times 0.3 \times 0.3 = 0.072$ $P(R'JL') = 0.6 \times 0.6 \times 0.4 = 0.144$ $P(R'J'L') = 0.2 \times 0.4 \times 0.3 = 0.024$ $P(L') = 0.224 + 0.072 + 0.144 + 0.024 = 0.464$</p> <p>(iii) Arrive late $P(L) = 1 - P(L')$ $= 1 - 0.464 = 0.536$</p> <p>(iv) Bus held in jam $P(J) = P(RJ) \text{ or } P(R'J)$ $= (0.8 \times 0.7) + (0.2 \times 0.6)$ $= 0.56 + 0.12 = 0.68$</p>	<p>B1</p> <p>B1</p> <p>B1</p> <p>M1</p> <p>M1 A1</p> <p>M1 A1</p> <p>M1 A1</p>	<p>All branches shown and their probabilities</p> <p>Probability space shown</p>
	Total	10	

NO.	WORKING	MARKS	REMARKS
20.	<p>(a) Coordinates of PQR</p> $\begin{pmatrix} -2 & 1 \\ 1 & 0 \end{pmatrix} \begin{pmatrix} a & b & c \\ d & e & f \end{pmatrix} = \begin{pmatrix} -1 & -5 & -1 \\ 1 & 4 & 2 \end{pmatrix}$ <p>Hence $\begin{pmatrix} a & b & c \\ d & e & f \end{pmatrix} = \begin{pmatrix} 1 & 4 & 2 \\ 1 & 3 & 3 \end{pmatrix}$</p> <p>$A(1, 1), B(4, 3)$ and $C(2, 3)$</p> <p>(b) Graphs</p> <p>(c) $\Delta A''B''C''$</p> <p>(i) Coordinates</p> $\begin{pmatrix} -1 & 0 \\ 0 & -2 \end{pmatrix} \begin{pmatrix} 1 & 4 & 2 \\ 1 & 3 & 3 \end{pmatrix} = \begin{pmatrix} 1 & 5 & 1 \\ -2 & -8 & -4 \end{pmatrix}$ <p>$A''(1, -2), B''(5, -8)$ and $C''(2, -4)$</p> <p>(ii) Drawn</p>  <p>(d) Transformation T Reflection in the line $x = 0$</p>	<p>M1</p> <p>A1</p> <p>B1</p> <p>B1</p> <p>B1</p> <p>B1</p> <p>B1</p> <p>B1</p> <p>B1</p> <p>B1</p> <p>B1</p> <p>B1</p>	<p>Premultiplying with matrix</p> <p>Object ABC matrix</p> <p>Coordinates of ΔABC</p> <p>ΔABC drawn</p> <p>$\Delta A'B'C'$ drawn</p> <p>$\Delta A''B''C''$ drawn</p> <p>Premultiplying</p> <p>Coordinates of $\Delta A''B''C''$</p> <p>$\Delta A'''B'''C'''$ drawn</p> <p>Reflection in the line $x = 0$</p>
	Total	10	

NO.	WORKING	MARKS	REMARKS																																													
21.	(a) Frequency distribution table																																															
	<table><tr><td>x</td><td>f</td><td>d</td><td>fd</td><td>fd^2</td></tr><tr><td>52</td><td>5</td><td>-3</td><td>-15</td><td>45</td></tr><tr><td>57</td><td>3</td><td>-2</td><td>-6</td><td>12</td></tr><tr><td>62</td><td>7</td><td>-1</td><td>-7</td><td>7</td></tr><tr><td>67</td><td>3</td><td>0</td><td>0</td><td>0</td></tr><tr><td>72</td><td>6</td><td>1</td><td>6</td><td>6</td></tr><tr><td>77</td><td>4</td><td>2</td><td>8</td><td>16</td></tr><tr><td>82</td><td>2</td><td>3</td><td>6</td><td>18</td></tr><tr><td></td><td>$\Sigma f = 30$</td><td></td><td>$\Sigma fd = -8$</td><td>$\Sigma fd^2 = 104$</td></tr></table>	x	f	d	fd	fd^2	52	5	-3	-15	45	57	3	-2	-6	12	62	7	-1	-7	7	67	3	0	0	0	72	6	1	6	6	77	4	2	8	16	82	2	3	6	18		$\Sigma f = 30$		$\Sigma fd = -8$	$\Sigma fd^2 = 104$	M1	All x ✓
	x	f	d	fd	fd^2																																											
	52	5	-3	-15	45																																											
	57	3	-2	-6	12																																											
	62	7	-1	-7	7																																											
	67	3	0	0	0																																											
	72	6	1	6	6																																											
	77	4	2	8	16																																											
	82	2	3	6	18																																											
	$\Sigma f = 30$		$\Sigma fd = -8$	$\Sigma fd^2 = 104$																																												
	M1	All f ✓ and $\Sigma f = 30$																																														
	M1	All d ✓																																														
	M1	All fd ✓ and $\Sigma fd = -8$																																														
	M1	All fd^2 ✓ and $\Sigma fd^2 = 104$																																														
	(b) Standard deviation																																															
	$s = c \sqrt{\frac{\Sigma fd^2}{\Sigma f} - \left(\frac{\Sigma fd}{\Sigma f}\right)^2} = 5 \sqrt{\frac{104}{30} - \left(\frac{-8}{30}\right)^2}$	M1, M1																																														
	$s = 9.214$	A1																																														
	(c) Mass																																															
	$60 - (11 \times 4.5) = 10.5 \text{ kg}$	M1, A1																																														
	Total	10																																														

NO.	WORKING	MARKS	REMARKS
22.	 <p>(a) Expression of vectors</p> <p>(i) $\mathbf{OM} = \mathbf{OA} + \mathbf{AM}$</p> $\mathbf{OM} = 12\mathbf{a} + \frac{1}{2}\mathbf{AB} = 12\mathbf{a} + \frac{1}{2}(-12\mathbf{a} + 12\mathbf{b})$ $\mathbf{OM} = 6\mathbf{a} + 6\mathbf{b}$ <p>(ii) $\mathbf{PM} = \mathbf{PO} + \mathbf{OM}$</p> $\mathbf{PM} = -\frac{1}{3}(12\mathbf{a}) + 6\mathbf{a} + 6\mathbf{b} = 2\mathbf{a} + 6\mathbf{b}$ <p>(b) (i) \mathbf{PR} in 2 ways</p> $\mathbf{PR} = k\mathbf{PB}$ $\mathbf{PR} = k(\mathbf{PO} + \mathbf{OB}) = k\left(-\frac{1}{3}(12\mathbf{a}) + 12\mathbf{b}\right)$ $\mathbf{PR} = -4k\mathbf{a} + 12k\mathbf{b}$ <p>Also, $\mathbf{PR} = \mathbf{PO} + \mathbf{OR}$</p> $\mathbf{PR} = -\frac{1}{3}(12\mathbf{a}) + h(6\mathbf{a} + 6\mathbf{b}) = (6h - 4)\mathbf{a} + 6h\mathbf{b}$ <p>(ii) Comparing the coefficients</p> $6h - 4 = -4k \rightarrow 6h + 4k = 4$ $6h = 12k \rightarrow h = 2k$ $6(2k) + 4k = 4 \rightarrow 16k = 4$ $k = \frac{1}{4}, \quad h = \frac{1}{2}$ <p>(c) A, R and Q collinear</p> <p>Consider \mathbf{AR} and \mathbf{AQ}</p> $\mathbf{AR} = \mathbf{AO} + \mathbf{OR} = -12\mathbf{a} + 3\mathbf{a} + 3\mathbf{b} = 3\mathbf{b} - 9\mathbf{a}$ $\mathbf{AQ} = -12\mathbf{a} + \frac{1}{3}(12\mathbf{b}) = -12\mathbf{a} + 4\mathbf{b} = 4\mathbf{b} - 12\mathbf{a}$ $\mathbf{AR} = \frac{3}{4}\mathbf{AQ} \rightarrow \mathbf{AR} // \mathbf{AQ}$ <p>Point A is common hence A, R and Q are collinear</p>	<p>B1</p> <p>B1</p> <p>B1</p> <p>B1</p> <p>M1</p> <p>A1, B1</p> <p>B1</p> <p>B1</p> <p>B1</p>	
	Total	10	

NO.	WORKING	MARKS	REMARKS
23.	<p>(a) Projection of VP on PQRS (VO)</p> $PR = \sqrt{16^2 + 12^2} = 20 \text{ cm}$ $VO = \frac{20}{2} = 10 \text{ cm}$ <p>(b) Angle between VP and PQRS</p> $\cos P = \frac{10}{18}$ $P = \cos^{-1}\left(\frac{10}{18}\right) = 56.25^\circ$ <p>(c) Angle between VQR and VPS</p> <p>Let T and W be the midpoints of QR and PS respectively</p> $VT = \sqrt{18^2 - 6^2} = \sqrt{288}$ <p>Consider ΔVTW</p> $16^2 = (\sqrt{288})^2 + (\sqrt{288})^2 - 2 \times \sqrt{288} \times \sqrt{288} \cos V$ $256 - 288 - 288 = -576 \cos V$ $-320 = -576 \cos V$ $V = \cos^{-1}\left(\frac{-320}{-576}\right) = 56.25^\circ$ <p>(d) Angle between VQR and PQRS</p> $\cos T = \frac{6}{\sqrt{288}}$ $T = \cos^{-1}\left(\frac{6}{\sqrt{288}}\right) = 69.30^\circ$	<p>M1</p> <p>A1</p> <p>M1</p> <p>A1</p> <p>M1</p> <p>M1</p> <p>M1, A1</p> <p>M1</p> <p>A1</p>	
	Total	10	

NO.	WORKING	MARKS	REMARKS																
24.	<p>(a) Coordinates of C and D $y = 4 - x$ and $y = x^2 + 2$ at C and D $4 - x = x^2 + 2$ $x^2 + x + 2 - 4 = 0$ $x^2 + x - 2 = 0$ Product $\rightarrow -2x^2$, Sum $\rightarrow x$ Factors $\rightarrow 2x, -x$ $x^2 + 2x - x - 2 = 0$ $x(x + 2) - 1(x + 2) = 0$ $(x - 1)(x + 2) = 0$</p> <p>$x - 1 = 0 \rightarrow x = 1, y = 3$ $x + 2 = 0 \rightarrow x = -2, y = 6$</p> <p>Hence C(1, 3) and D(-2, 6)</p> <p>(b) Area by trapezium rule $h = \frac{1 - (-2)}{6} = \frac{1}{2}$</p> <table border="1"><tr><td>x</td><td>-2</td><td>-1.5</td><td>-1</td><td>-0.5</td><td>0</td><td>0.5</td><td>1</td></tr><tr><td>y</td><td>6</td><td>5.5</td><td>5</td><td>4.5</td><td>4</td><td>3.5</td><td>3</td></tr></table> <p>$A = \frac{1}{2} \times \frac{1}{2} \{ (6 + 3) + 2(5.5 + 5 + 4.5 + 4 + 3.5) \}$ $A = \frac{1}{4} \{ (9) + 2(22.5) \}$ $A = \frac{1}{4} \{ 9 + 45 \} = 13.5$</p> <p>(c) Exact area $A = \int_{-2}^1 (x^2 + 2) dx$ $A = \left[\frac{x^3}{3} + 2x + c \right]_{-2}^1$ $A = \left(\frac{1}{3} + 2 + c \right) - \left(\frac{-2^3}{3} + 2 \times -2 + c \right)$ $A = 2\frac{1}{3} + c - \left(-\frac{20}{3} + c \right)$ $A = 2\frac{1}{3} + c + \frac{20}{3} - c = 9$</p>	x	-2	-1.5	-1	-0.5	0	0.5	1	y	6	5.5	5	4.5	4	3.5	3	<p>M1</p> <p>M1</p> <p>A1</p> <p>B1</p> <p>M1</p> <p>B1</p> <p>M1</p> <p>A1</p> <p>M1</p> <p>M1</p> <p>A1</p>	<p>Equating the two functions</p> <p>✓ attempt to solve the resultant quadratic equation Both values of x ✓</p> <p>Coordinates of C and D</p> <p>Height of trapezia</p> <p>Table of values</p> <p>Trapezium</p> <p>Integration</p> <p>Substituting the limits</p>
x	-2	-1.5	-1	-0.5	0	0.5	1												
y	6	5.5	5	4.5	4	3.5	3												
	Total	10																	