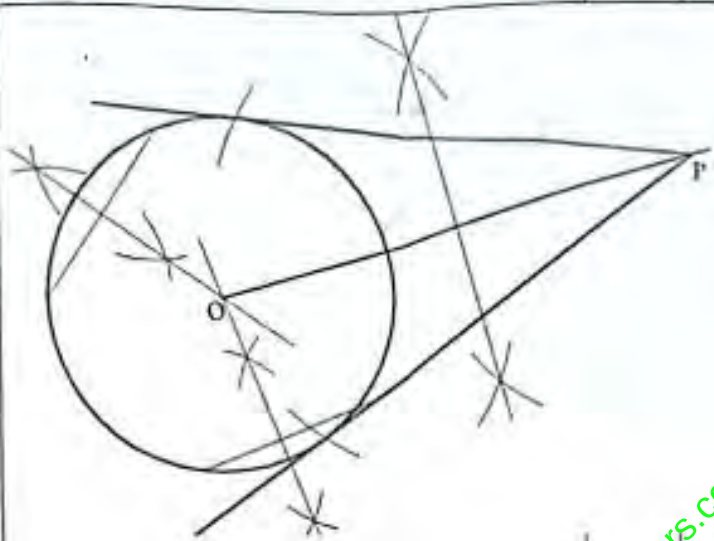
121/2 MATHEMATICS ALT. A

SECTION I

No.	Marking scheme	Marks	Comments
1.	Vol. of water geting to the tank in 1sec $= \frac{22}{7} \times 0.014^2 \times 2$ $= 0.001232\ m^3$ Time needed to fill tank $= \frac{18.48}{0.001232}$ $= 15000\ sec$ $= 4\frac{1}{6}$ hours	M1 M1 A1 3	Compatible $\frac{18450}{1.232}$ EQ C.A.O
2.	n^{th} term $= 2 \times 2^{n-1}$ $(n-1)^{th}$ term $= 2 \times 2^{n-2}$ $2 \times 2^{n-1} \times 2 \times 2^{n-2} = 512$ $2^{2n-1} = 2^9$ $2n-1 = 9$ $n = 5$	B1 M1 A1 3	Two terms seen Expression
3.	$4 \times a \times 9 = (-30)^2$ $a = \frac{900}{36}$ $= 25$	M1 A1 2	$b^2 - 4ac = 0$ (Subst.)
4.	$y^2 = \frac{b^2x^2}{cx^2 - a}$ $cx^2y^2 - ay^2 = b^2x^2$ $cx^2y^2 - b^2x^2 = ay^2$ $x^2(cy^2 - b^2) = ay^2$ $x = \pm\sqrt{\frac{ay^2}{cy^2 - b^2}}$	M1 M1 A1 3	✓ removal of ✓ sign x^2 factored out Allow if ± is missing.

Alt
2, 4, 8, 16, 32 B1
$16 \times 32 = 512$ M1
$n = 5$ A1
OR Let no last term be x
$x \cdot \frac{x}{2} = 512$
$x^2 = 512 \times 2$
$x^2 = 1024$ $x = 32$ B1
$2 \cdot 2^{n-1} = 32$ M1
$2^{n-1} = 16$
$2^{n-1} = 2^4$
$n = 5$ A1

No.	Marking scheme	Marks	Comments
5.		B1 B1 B1 B1	Locating centre O ✓ ⊥ bisector of OP ✓ Arc showing the correct position of point of contact of circle and tangent ✓ (one tangent is sufficient) √ tangent drawn
		4	
6.	$P = k\frac{\sqrt{Q}}{(R-S)^2}$ →	B1	eqn.
	New value of P after changes in Q, R and S		
	$P' = k\frac{\sqrt{1.44Q}}{(0.9R-0.9S)^2}$ →	M1	New P.
	$= k\frac{1.2\sqrt{Q}}{0.9^2(R-S)^2}$		
	$= 1.481k\frac{\sqrt{Q}}{(R-S)^2}$		
	$= 1.481kP$ →	A1	
	$(1.481-1)\times 100\%$	M1	– % change in P
	Thus, P increases by 48.1% →	A1	Allow 48.1% or 48.2%
		4	

$\frac{(1.481P-P)}{P}100\%$

$(1.4815-1)100\%$ B1 M1

$= 48.2\%$ A1

No.	Marking scheme	Marks	Comments
7.	Let point A' be the projection of point A on the plane GFEH		
	$AA' = \sqrt{(5^2 - 3^2)}$	M1	Any ✓ Can be implied at $\sqrt{}$ level
	$= 4$		
	$FA' = \sqrt{(6^2 + 8^2)}$		
	$= 10$		
	$\tan\theta = \frac{4}{10} = 0.4$	M1	or equivalent
	$\theta = 21.8°$	A1	
		3	
8.	Balance upon paying deposit :		
	$= 20000 - 10000$		
	$= 10000$		
	Amount Repaid		
	$= 900 \times 18$		
	$= 16200$	B1	for 16,200 seen
	Let r = rate of interest per annum		
	$16200 = 10000\left(1 + \frac{\left(\frac{r}{4}\right)}{100}\right)^6$	M1	
	$= 10000\left(1 + \frac{r}{400}\right)^6$		
	$1 + \frac{r}{400} = \sqrt[6]{1.62} = 1.084$	M1	$\sqrt[6]{1.62}$ Must be obtained
	$r = (1.084 - 1) \times 400$		
	$= 33.6\%$ or 33.5%	A1	
		4	

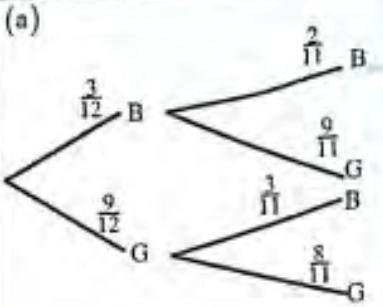
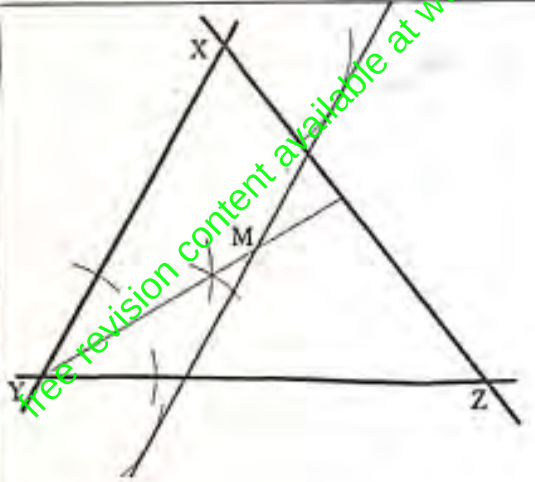
AHC

$\sin\theta = \frac{4}{10.77}$

or

$\cos\theta = \frac{10}{10.77}$

No.	Marking scheme	Marks	Comments
9.	(a) 	P1	√ plotting (All pairs √ plo
		C1	smooth curve
	(b)	B1	√ tangent drawn
	Gradient $= \frac{0-2.7}{6-3}$		
	$= -0.9 \pm 0.1$	B1	
		4	
10.	(a) $\frac{360}{a} = 180$		
	$a = 2$	B1	
	(b) Phase Angle = ~~90~~ 70°	B1	
		2	
11.	Let θ = longitude difference between P and Q		
	$\theta \times 60 \cos 40 = 2000$	M1	
	$\theta = \frac{2000}{60 \cos 40}$		
	= ~~43.5°~~ 43.51°	~~M1~~	
	155 + 43.51 = 198.51°		
	Longitude of Q		
	= 360° − 198.51°	M1	− 180° − 18.51° (equiva
	~~= 161.5° E~~	A1	
	= 161° E	3	

No.	Marking scheme	Marks	Comments
12.	(a)  	B1	All probabilities indicated are correct
	(b) P(Balls picked are of different colours) $= \frac{3}{12} \times \frac{9}{11} + \frac{9}{12} \times \frac{3}{11}$ $= \frac{27}{132} + \frac{27}{132}$ $= \frac{54}{132}$	M1 A1 3	addition (Condone) or equivalent (Accept ~~9/22~~) 18/44 or 9/22
13.	 YM = (4 ± 0.1) cm	B1 B1 B1 3	Angle bisector of ∠XYZ √ construction of a straight line 2 cm from and parallel to line XY OW –1 if point M is not marked

No.	Marking scheme	Marks	Comments
14.	$\mathbf{PQ} = \begin{pmatrix}12\\-5\\6\end{pmatrix} - \begin{pmatrix}6\\-2\\3\end{pmatrix} = \begin{pmatrix}6\\-3\\3\end{pmatrix}$ .....(i) $\mathbf{PR} = \begin{pmatrix}8\\-3\\4\end{pmatrix} - \begin{pmatrix}6\\-2\\3\end{pmatrix} = \begin{pmatrix}2\\-1\\1\end{pmatrix}$ .....(ii) If PQ and PR are parallel, then PQ = kPR $\begin{pmatrix}6\\-3\\3\end{pmatrix} = k\begin{pmatrix}2\\-1\\1\end{pmatrix}$ k = 3 $\therefore$ ~~PQ = $\frac{1}{3}$PR~~ PQ = 3PR P is a common point Points P, Q and R are collinear	B1 B1 M1 B1 3	For either (i) and (ii) or equivalent. or equivalent (Constant and Parallelism) Parallelism Common point & Conclusion
15.	$3x^2 - 7(x-1) = \frac{13x}{x}$, $x \neq 0$ $3x^2 - 7x - 6 = 0$ $(3x+2)(x-3) = 0$ $x = -\frac{2}{3}$ or $x = 3$	M1 M1 A1 3	Det = A.S.F Attempt to solve. or equivalent
16.	$\int_1^3 (x^2 + 2x)\,dx = \left[\frac{x^3}{3} + x^2\right]_1^3$ $= \left(\frac{3^3}{3} + 9\right) - \left(\frac{1}{3} + 1\right)$ $= 18 - 1\frac{1}{3}$ $= 16\frac{2}{3}$ sq. units	M1 M1 A1 3	✓ integral with limits (can be implied) Substitution (implied if Substitution of limits (Subtraction done)) C.A.O

SECTION II (50 MARKS)

No.	Marking scheme	Mark	Comments
17.	(a) Fraction of tank filled by pumps P and Q in 1hr $= \frac{1}{7\frac{1}{2}} + \frac{1}{11\frac{1}{4}} = \frac{2}{15} + \frac{4}{45}$ $= \frac{2}{9}$	M1	
	Fraction of tank filled by pumps P and Q in $2\frac{1}{2}$ hrs $= \frac{2}{9} \times \frac{5}{2}$ $= \frac{5}{9}$	M1	
	Fraction of tank still empty $= 1 - \frac{5}{9}$ $= \frac{4}{9}$	M1 A1	(can be implied in accuracy)
	(b) Time taken by pump P alone to fill $\frac{4}{9}$ of the tank $= \frac{4}{9} \div \frac{2}{15}$ $= \frac{4}{9} \times \frac{15}{2}$ $= 3\frac{1}{3}$ hrs	M1 A1	3hrs 20mins.
	(c) Total time Pump P has pumped $= 2\frac{1}{2} + 3\frac{1}{3}$ $= 5\frac{5}{6}$ hours		
	Fraction of tank delivered by pump P $= \frac{2}{15} \times 5\frac{5}{6}$ $= \frac{7}{9}$	M1 A1	or equivalent
	Amount received by propriator of Pump P $= \frac{7}{9} \times 15\,750$ = Ksh 12 250	M1 A1	or equivalent
		10	

No.	Marking scheme	Mark	Comments
18.	(a) (i) Area of lawn		
	$= (50 - 4x)(24 - 2x)$	M1	
	$= 1200 - 100x - 96x + 8x^2$		
	$= 1200 - 196x + 8x^2$	A1	
	(ii) Area of path		
	$= 50 \times 24 - (1200 - 196x + 8x^2)$		
	$= 1200 - 1200 + 196x - 8x^2$		
	$= 196x - 8x^2$	B1	
	(b) (i) $196x - 8x^2 = \frac{3}{2}(1200 - 196x + 8x^2)$	M1	
	$= 1800 - 294x + 12x^2$		
	$20x^2 - 490x + 1800 = 0$	M1	– Must be correct
	$2x^2 - 49x + 180 = 0$		
	$(2x - 9)(x - 20) = 0$	M1	✓ Attempt to solve
	$x = 4.5$ or $x = 20$	A1	✓ for both values of x (2 multiples)
	(ii) Length of lawn		
	$= 50 - 4 \times 4.5$		
	$= 32$ m	B1	For √ length or width (any)
	Width of lawn		
	$= 24 - 2 \times 4.5$		
	$= 15$ m		
	Perimeter of lawn		
	$= 2(32 + 15)$	M1	
	$= 94$ m	A1	

No.	Marking scheme	Mark	Comments
19.	(a) (i) Size of $\angle AEC$		
	$\angle ABE = 30°$	B1	
	(Angle in alternate segment)		
	$\angle CBE = 70°$	B1	
	(Opposite angle of a cyclic quadrilateral)		
	$\angle AEC = [180 - (30+70)] = 80°$	B1	for 80°
	(Opposite angle of a cyclic quadrilateral)		
	(ii) $\angle BOC = 180 - 2\times55 = 70°$	B1	for 70°
	$\angle BEC = 35°$	B1	for 35°
	(Angle at the circumference is half angle at centre)		
	$\angle AEB = 80 - 35° = 45°$	B1	for 45°
	(b) (i) Let radius of circle = R		
	$2R = \frac{5}{\sin 45°}$	M1	
	$R = 3.5\,cm$	A1	
	(ii) $AF^2 = \sqrt{2.5\times(2.5 + 4.4)}$	M1	
	$AF = \sqrt{17.25}$		
	$= 4.2\,cm$	A1	
	$\angle BAE$		
		10	

Truncation / Method Error
Rounding off / Numerical Error

No.	Marking scheme	Mark	Comments
20.	(a) Taxable income		
	$= 64\,500 + 12\,000 - \frac{7.5}{100} \times 64\,500$	M1	
	= Ksh 71 662.50	A1	
	(b) Tax payable by Kanini		
	1st slab $= 12298 \times \frac{10}{100} = 1\,229.80$	M1	
	2nd slab $= 11587 \times \frac{15}{100} = 1\,738.05$	M1	
	3rd slab $= 11587 \times \frac{20}{100} = 2\,317.4$		
	4th slab $= 11587 \times \frac{25}{100} = 2\,896.75$		
	5th slab $= 24603.50 \times \frac{30}{100} = 7\,381.05$	M1	
	Total tax = 15563.05	A1	
	Tax less relief		
	= Ksh 15 563.05 − 1408	M1	
	= Ksh 14 155.05	A1	Part c
	(c) Total deductions		
	$= 14\,155.05 + \frac{7.5}{100} \times 64\,500$		
	= 18 992.55		
	Net income = 64 500 + 12000 − 18 992.55	M1	Allow 71,662.50 − 14155.50
	= 57 507.45	A1	= 57,507.45
		10	

Alt

When tax relief is not deducted

a) M0
A0

b) M1
M1
M0
A0

No.	Marking scheme	Mark	Comments
21.	(a) Inverse of transformation matrix		
	$= \frac{1}{(0-1)}\begin{pmatrix} -2 & -1 \\ -1 & 0 \end{pmatrix}$	M1	
	$= \begin{pmatrix} 2 & 1 \\ 1 & 0 \end{pmatrix}$	A1	
	Coordinates of triangle ABC		
	$= \begin{pmatrix} 2 & 1 \\ 1 & 0 \end{pmatrix} \times \begin{pmatrix} 3 & 1 & 3 \\ -3 & -1 & -1 \end{pmatrix}$	M1	
	$= \begin{pmatrix} 3 & 1 & 5 \\ 3 & 1 & 3 \end{pmatrix}$		
	Coordinates of triangle ABC are A(3, 3), B(1, 1) and C(5, 3)	A1	
	(b) Coordinates of triangle A"B"C"		
	$= \begin{pmatrix} -2 & 0 \\ 0 & -1 \end{pmatrix} \times \begin{pmatrix} 3 & 1 & 3 \\ -3 & -1 & -1 \end{pmatrix}$	M1	
	$= \begin{pmatrix} -6 & -2 & -6 \\ 3 & 1 & 1 \end{pmatrix}$		Can directly plotted
	Coordinates of triangle A"B"C" are A"(−6, 3), B"(−2, 1) and C"(−6, 1)	A1	

All marking

21

a) $\begin{pmatrix} 0 & 1 \\ 1 & -2 \end{pmatrix}\begin{pmatrix} a & c & e \\ b & d & f \end{pmatrix} = \begin{pmatrix} 3 & 1 & 3 \\ -3 & -1 & -1 \end{pmatrix}$ ABC

$b=3,\ d=1,\ f=3$ A1

$a-2(3)=-3$

$a-6=-3$

$a=3$

$c-2d=-1$

$c-2(1)=-1$

$c-2=-1$

$c=1$

$e-2f=-1$

$e-2(3)=-1$

$e-6=-1$

$e=5$

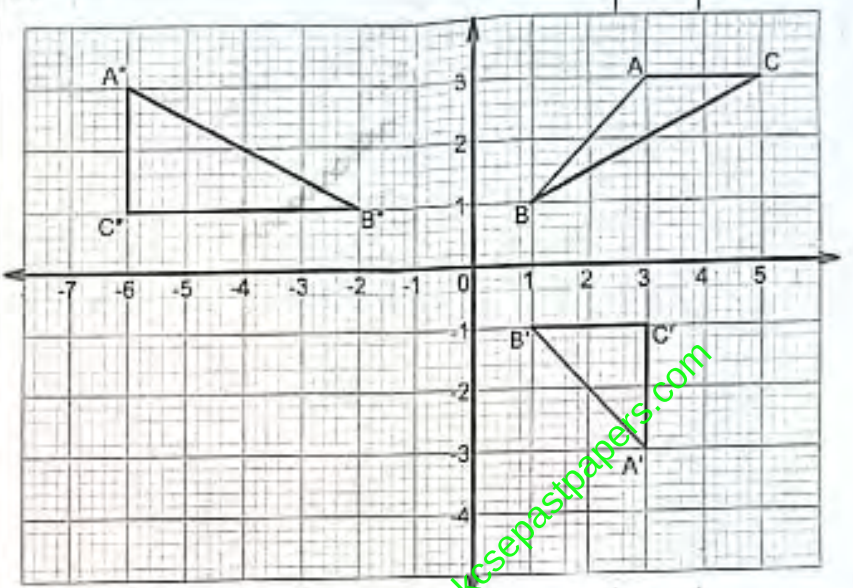
$\begin{matrix} A & B & C \end{matrix}$

$\begin{pmatrix} 3 & 1 & 5 \\ 3 & 1 & 3 \end{pmatrix}$

A(3,3) B(1,1)

C(5,3) A1 coordinates

M1 attempt to solve

No.	Marking scheme	Mark	Comments
	(c) 		
		B1	√ Δ ABC drawn (ft wrong vertex)
		B1	√ Δ A"B"C" drawn
	(d) Single matrix to map ABC onto A"B"C"		
	$= \begin{pmatrix} -2 & 0 \\ 0 & -1 \end{pmatrix}\begin{pmatrix} 0 & 1 \\ 1 & -2 \end{pmatrix}$	M1	
	$= \begin{pmatrix} 0 & -2 \\ -1 & 2 \end{pmatrix}$	A1	
		10	

Alt

21 (a) $\begin{pmatrix} 0 & 1 \\ 1 & -2 \end{pmatrix}\begin{pmatrix} a & c & e \\ b & d & f \end{pmatrix} = \begin{pmatrix} 3 & 1 & 3 \\ -3 & -1 & -1 \end{pmatrix}$ ✓ M1

A B C

$f=3$

$b=3,\ d=1,\ f=3$ ✓ A1

$c=5$

$d=-3$

$a+2(-3)=3$ ✓

M1 – attempt to solve

– (x-ordinates

(d) $\begin{pmatrix} a & b \\ c & d \end{pmatrix}\begin{pmatrix} 3 & 1 & 5 \\ -3 & -1 & 3 \end{pmatrix} = \begin{pmatrix} -6-3 & \\ 3 & \end{pmatrix}$

Attempt to solve a pair M1

Single matrix A1

No.	Marking scheme	Mark	Comments
22.	(a)		

Mid point x	f	xf	x^2f
3	3	9	27
8	6	48	284 384
13	t	13t	1352
18	7	126	2268
23	4	92	2116
28	2	56	1568
	$\Sigma f = 22 + t$	$\Sigma xf = 331 + 13t$	$\Sigma x^2 f = 7715$

B1 fx (with t) or equivalent

~~B1~~ fx^2 (without t)

$\frac{331 + 13t}{22 + t} = 14.5$ → M1

$t = 8$ → A1

S.d

Variance $= \sqrt{\frac{7715}{30} - 14.5^2}$ → B1 $\int x^2$ (without t) M1

$= 46.92$

Standard deviation $= \sqrt{46.92}$

$= 6.85$ → A1

(b)

UCB	5.5	10.5	15.5	20.5	25.5	30.5
C.F	3	9	17	24	28	30

→ B1 for cf (Can be implied in the quartiles)

$Q_3 = 15.5 + \frac{5.5}{7} \times 5$

$= 19.43$ → M1 Any seen

$Q_1 = 5.5 + \frac{4.5}{6} \times 5$

$= 9.25$

Interquartile range

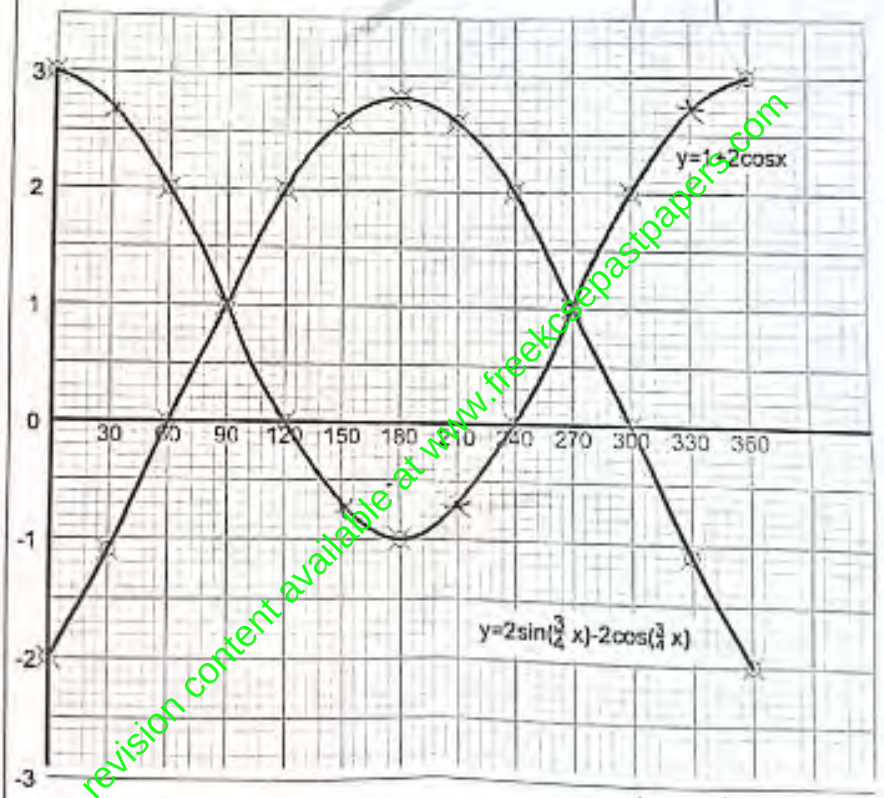
$Q3 - Q1 = 19.43 - 9.25$ → M1 difference (Allow if one quartile is numerically wrong)

$= 10.18$ → A1

10

No.	Marking scheme	Mark	Comments
23.	(a)	B2	All 7 √ (1 d.p.) Allow B1 for any 5 √

x	30°	90°	150°	210°	300°	330°
$2\sin\left(\frac{3}{4}x\right) - 2\cos\left(\frac{3}{4}x\right)$		1.1	2.6	2.6		-1.1
$1+2\cos x$	2.7			-0.7	2	



$2\sin\left(\frac{3}{4}x\right) - 2\cos\left(\frac{3}{4}x\right)$ — P1 ✓ plotting, C1 ✓ smooth curve

$(1 + 2\cos x)$ — P1 ✓ plotting, C1 ✓ smooth curve.

No.	Marking scheme	Mark	Comments
	(c) (i) When $y=2$	B1	line $y=2$ drawn. (May be implied)
	$2\sin\left(\frac{3}{4}x\right) - 2\sin\left(\frac{3}{4}x\right) = 2$ then		
	$\sin\left(\frac{3}{4}x\right) = 1+\sin\left(\frac{3}{4}x\right)$		
	$x = 120°$ or $x = 240°$	B1	
	(ii) ~~$90° < x < 270°$~~ $87° < x < 273°$ $\pm 2°$.	B2	Allow B1 for one inequality √
	$85°-89°$ $271°-275°$		

No.	Marking scheme	Mark	Comments
24.	(a) $v = \int(4t - 13)dt$		
	$= 2t^2 - 13t + c$	M1	✓ integration with C (Can be implied)
	when $t = 0, v = 18$		
	$18 = 2\times0 - 13\times0 + c$		
	$c = 18$		
	$v = 2t^2 - 13t + 18$	A1	Allow $2t^2-13t+18$.
	When $v = 0$		
	$2t^2 - 13t + 18 = 0$	M1	
	$(2t - 9)(t - 2) = 0$	M1	✓ attempt to solve. Equivalent ll.
Deny if ½ is used	$t = 4.5$ or $t = 2$	A1	for both.
	(b) Distance covered by particle		
	Area above x axis		
	$\int_1^2(2t^2 - 13t + 18)dt$		
	$= \left[\frac{2}{3}t^3 - \frac{13}{2}t^2 + 18t\right]_1^2$	M1	Allow 1 & 3 limits
	$= \left[\frac{2}{3}\times2^3 - \frac{13}{2}\times2^2 + 18\times2\right] - \left[\frac{2}{3}\times1^3 - \frac{13}{2}\times1^2 + 18\times1\right]$	M1	
	$= \left[\frac{16}{3} - 26 + 36\right] - \left[\frac{2}{3} - \frac{13}{2} + 18\right]$		
	$= 15\frac{1}{3} - 12\frac{1}{6}$		
	$= 3\frac{1}{6}$	A1	Allow 19/6
	Area below x axis		
	$= \left[\frac{2}{3}\times3^3 - \frac{13}{2}\times3^2 + 18\times3\right] - 15\frac{1}{3}$	M1	Allow substitution for both.
	$= \left[18 - \frac{117}{2} + 54\right] - 15\frac{1}{3}$		
	$= -1\frac{5}{6}$		
	$= 1\frac{5}{6}$	A1	Allow 11/6
	Total area		
	$= 3\frac{1}{6} + 1\frac{5}{6}$		
	$= 5$ m	B1	
		10	

(b) Integration from 1-3 M1✓ Integration

A-0