Question	Scheme	Marks	AOs
15(a)	$R=\sqrt{5}$	B1	1.1b
	$\tan\alpha=\frac{1}{2}$ or $\sin\alpha=\frac{1}{\sqrt{5}}$ or $\cos\alpha=\frac{2}{\sqrt{5}}\Rightarrow\alpha=...$	M1	1.1b
	$\alpha=0.464$	A1	1.1b
		(3)	
(b)(i)	$3+2\sqrt{5}$	B1ft	3.4
(ii)	$\cos(0.5t+0.464)=1\Rightarrow 0.5t+0.464=2\pi$ $\Rightarrow t=...$	M1	3.4
	t = 11.6	A1	1.1b
		(3)	
(c)	$3+2\sqrt{5}\cos(0.5t+0.464)=0$ $\cos(0.5t+0.464)=-\frac{3}{2\sqrt{5}}$	M1	3.4
	$\cos(0.5t+0.464)=-\frac{3}{2\sqrt{5}}\Rightarrow 0.5t+0.464=\cos^{-1}\left(-\frac{3}{2\sqrt{5}}\right)$ $\Rightarrow t=2\left(\cos^{-1}\left(-\frac{3}{2\sqrt{5}}\right)-0.464\right)$	dM1	1.1b
	So the time required is e.g.: $2(3.977...-0.464)-2(2.306...-0.464)$	dM1	3.1b
	= 3.34	A1	1.1b
		(4)	
(d)	e.g. the "3" would need to vary	B1	3.5c
		(1)	
			(11 marks)

Notes

(a)

B1: $R=\sqrt{5}$ only.

M1: Proceeds to a value for α from $\tan\alpha=\pm\frac{1}{2}$ or $\sin\alpha=\pm\frac{1}{"R"}$ or $\cos\alpha=\pm\frac{2}{"R"}$

It is implied by either awrt 0.464 (radians) or awrt 26.6 (degrees)

A1: $\alpha=$awrt 0.464

(b)(i)

B1ft: For $\left(3+2\sqrt{5}\right)$m or awrt 7.47 m and remember to isw. Condone lack of units.

Follow through on their R value so allow 3 + 2×Their R. (Allow in decimals with at least 3sf accuracy)

(b)(ii)

M1: Uses $0.5t\pm"0.464"=2\pi$ to obtain a value for t

Follow through on their 0.464 but this angle must be in radians.

It is possible in degrees but only using $0.5t\pm"26.6"=360$

A1: Awrt 11.6

Question	Scheme	Marks	AOs
8 (a)	$D = 5 + 2\sin(30 \times 6.5)° = \text{awrt } 4.48\,\text{m}$ with units	B1	3.4
		(1)	
(b)	$3.8 = 5 + 2\sin(30t)° \Rightarrow \sin(30t)° = -0.6$	M1 A1	1.1b 1.1b
	$t = 10.77$	dM1	3.1a
	10:46 a.m. or 10:47 a.m.	A1	3.2a
		(4)	
			(5 marks)

Notes:

(a)

B1: Scored for using the model ie. substituting $t = 6.5$ into $D = 5 + 2\sin(30t)°$ and stating $D = awrt\ 4.48\text{m}$. The units must be seen somewhere in (a) . So allow when $D = 4.482.. = 4.5\ \text{m}$

Allow the mark for a correct answer without any working.

(b)

M1: For using $D = 3.8$ and proceeding to $\sin(30t)° = k, \quad |k| \leq 1$

A1: $\sin(30t)° = -0.6$ This may be implied by any correct answer for *t* such as $t = 7.2$

If the A1 implied, the calculation must be performed in degrees.

dM1: For finding **the first value** of *t* for their $\sin(30t)° = k$ after $t = 8.5$.

You may well see other values as well which is not an issue for this dM mark

(Note that $\sin(30t)° = -0.6 \Rightarrow 30t = 216.9°$ as well but this gives $t = 7.2$)

For the correct $\sin(30t)° = -0.6 \Rightarrow 30t = 323.1 \Rightarrow t = \text{awrt } 10.8$

For the incorrect $\sin(30t)° = +0.6 \Rightarrow 30t = 396.9 \Rightarrow t = \text{awrt } 13.2$

So award this mark if you see $30t = \text{inv}\sin\ their - 0.6$ to give the first value of *t* where 30 *t* > 255

A1: Allow 10:46 a.m. (12 hour clock notation) or 10:46 (24 hour clock notation) oe

Allow 10:47 a.m. (12 hour clock notation) or 10:47 (24 hour clock notation) oe

DO NOT allow 646 minutes or 10 hours 46 minutes.

Question	Scheme	Marks	AOs
6 (a)	$R=\sqrt{5}$	B1	1.1b
	$\tan\alpha=2\Rightarrow\alpha=...$	M1	1.1b
	$\alpha=1.107$	A1	1.1b
		(3)	
	$\theta=5+\sqrt{5}\sin\left(\frac{\pi t}{12}+1.107-3\right)$		
(b)	$\left(5+\sqrt{5}\right)$ °C or awrt 7.24 °C	B1ft	2.2a
		(1)	
(c)	$\frac{\pi t}{12}+1.107-3=\frac{\pi}{2}\Rightarrow t=$	M1	3.1b
	$t=$ awrt 13.2	A1	1.1b
	Either 13:14 or 1:14 pm or 13 hours 14 minutes after midnight.	A1	3.2a
		(3)	
			(7 marks)
Notes:			

(a)

B1: $R=\sqrt{5}$ only.

M1: Proceeds to a value of α from $\tan\alpha=\pm2,\tan\alpha=\pm\frac{1}{2},\sin\alpha=\pm\frac{2}{"R"}$ OR $\cos\alpha=\pm\frac{1}{"R"}$

It is implied by either awrt 1.11 (radians) or 63.4 (degrees)

A1: $\alpha=$ awrt 1.107

(b)

B1ft: Deduces that the maximum temperature is $\left(5+\sqrt{5}\right)$ °C or awrt 7.24 °C Remember to isw

Condone a lack of units. Follow through on their value of *R* so allow $(5+"R")$ °C

(c)

M1: An complete strategy to find *t* from $\frac{\pi t}{12}\pm1.107-3=\frac{\pi}{2}$.

Follow through on their 1.107 but the angle must be in radians.

It is possible via degrees but only using $15t\pm63.4-171.9=90$

A1: awrt $t=13.2$

A1: The question asks for the time of day so accept either 13:14, 1:14 pm, 13 hours 14 minutes after midnight, 13h 14, or 1 hour 14 minutes after midday. If in doubt use review

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It is possible to attempt parts (b) and (c) via differentiation but it is unlikely to yield correct results.

$\frac{d\theta}{dt}=\frac{\pi}{12}\cos\left(\frac{\pi t}{12}-3\right)-\frac{2\pi}{12}\sin\left(\frac{\pi t}{12}-3\right)=0\Rightarrow\tan\left(\frac{\pi t}{12}-3\right)=\frac{1}{2}\Rightarrow t=13.23=13:14$ scores M1 A1 A1

$\frac{d\theta}{dt}=\cos\left(\frac{\pi t}{12}-3\right)-2\sin\left(\frac{\pi t}{12}-3\right)=0\Rightarrow\tan\left(\frac{\pi t}{12}-3\right)=\frac{1}{2}\Rightarrow t=13.23=13:14$ they can score M1 A0 A1 (SC)

A value of $t=1.23$ implies the minimum value has been found and therefore incorrect method M0.

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Question Number	Scheme	Marks
13. (a)	$R = \sqrt{5} = 2.23606...$ (must be given in part (a))	B1
	$\tan\alpha = \frac{1}{2}$ or $\sin\alpha = \frac{1}{\sqrt{5}}$ or $\cos\alpha = \frac{2}{\sqrt{5}}$ (see notes for other values which gain M1)	M1
	$\Rightarrow \alpha = 26.56505...^\circ$ (must be given in part (a))	A1 **[3]**
(b)	Way 1: Uses distance between two lines is 4 (or half distance is 2) with correct trigonometry **may** state $4\sin\theta + 2\cos\theta = 4$ **or** show sketch	M1
	Need sketch **and** $4\sin\theta + 2\cos\theta = 4$ **and** deduction that $2\sin\theta + \cos\theta = 2$ or $\cos\theta + 2\sin\theta = 2$ *	A1 * **[2]**
	Way 2: **Alternative method:** Uses diagonal of rectangle as hypotenuse of right angle triangle and obtains $\sqrt{20}\sin(\theta + \alpha) = 4$	M1
	So from (a) $2\sin\theta + \cos\theta = 2$ or $\cos\theta + 2\sin\theta = 2$	A1 **[2]**
	Way 3: They may state and verify the result provided the work is correct and accurate See notes below. **Substitution of 36.9** (obtained in (c) is a circular argument and is **M0A0**)	
(c)	Way1: Uses $\sqrt{5}\sin(\theta + 26.57) = 2$ to obtain $\sin(\theta + "26.57") = \frac{2}{"\sqrt{5}"}$ $(= 0.8944...)$ $\theta = \arcsin\left(\frac{2}{\text{their } "\sqrt{5}"}\right) - "26.57"$	Way 2 $\cos^2\theta + 4\cos\theta\sin\theta + 4\sin^2\theta = 4$ See notes for variations $4\cos\theta\sin\theta - 3\cos^2\theta = 0$ $\cos\theta(4\sin\theta - 3\cos\theta) = 0$ so $\tan\theta = \frac{3}{4}$ $\theta = \arctan\frac{3}{4}$ or equivalent
	Hence, $\theta = 36.8699...^\circ$	A1 **[3]**
(d)	Way 1: $"x" = \frac{2}{\tan"36.9"}$ $\{h + x = 4 \Rightarrow\}$ $h + \frac{2}{\tan"36.9"} = 4$ $h = 4 - \frac{2}{\tan 36.9} = 1.336...$ or $\frac{4}{3}$ or $\underline{1.3}$ (2sf)	Way 2: "y" $= \frac{4}{\sin\theta}$ $\{h + y = 8 \Rightarrow\}$ $h + \frac{4}{\sin"36.9"} = 8$ $h = 8 - \frac{4}{\sin 36.9} = \frac{4}{3}$ or $\underline{1.3}$ (2sf)
		B1 M1 A1 **cao** **[3]**
		11

Question Number	Scheme	Marks
13(a)	$R = \sqrt{109}$	B1
	$\tan\alpha = \frac{3}{10} \Rightarrow \alpha = \text{awrt} 16.70°$	M1A1
		(3)
(b)(i)	Max height = 12+ ' $\sqrt{109}$ '= 22.44 m	M1A1
(ii)	Occurs when $30t + '16.70' = 180 \Rightarrow t = 5.44$	M1A1
		(4)
(c)	$18 = 12 - \sqrt{109}\cos(30t + 16.70) \Rightarrow \cos(30t + 16.70) = -\frac{6}{\sqrt{109}}$ $(-0.57..)$	M1A1
	$\Rightarrow 30t + 16.70 = \text{arc}\cos\left(-\frac{6}{\sqrt{109}}\right) \Rightarrow t = ..$	dM1
	$t = \text{awrt } 3.61 (2\text{dp})$	A1
		(4)
(d)	Attempting $30t = 360 \Rightarrow t = ..$ or $30t = 720 \Rightarrow t = ..$	M1
	2 revolutions in 24 **minutes**	A1
		(2)
		(13 marks)

Question Number	Scheme	Marks
11(a)	$(R=\sqrt{1.5^2+1.2^2})=$ awrt 1.921 - accept e.g. $\sqrt{3.69}$ or $\frac{3\sqrt{41}}{10}$	B1
	$\tan\alpha=\frac{1.2}{1.5}\Rightarrow\alpha=0.675$ or 0.215π	M1A1
		(3)
(b)	$H=3+1.921\sin\left(\frac{\pi t}{6}-0.675\right)$	
	$H_{\min}=3-'1.921'=$ awrt 1.08	M1A1
	$\left(\frac{\pi t}{6}-"0.675"\right)=\frac{3\pi}{2}\Rightarrow t=10.29$	M1A1
		(4)
(c)	$4=3+1.921\sin\left(\frac{\pi t}{6}-0.675\right)\Rightarrow\sin\left(\frac{\pi t}{6}-0.675\right)=\frac{1}{1.921}$	M1
	$\frac{\pi t}{6}-0.675=0.548\Rightarrow t=$ awrt 2.33 or 2.34	dM1A1
	$\frac{\pi t}{6}-0.675=\pi-0.548=2.594\Rightarrow t=$ awrt 6.24 or 6.25	ddM1A1
	Times are 2:20pm and 6:15pm or 6.14pm (14:20 and 18:15 or 18:14) – allow 2 hours 20minutes and 6 hours 15 or 14minutes or 140 minutes and 375 or 374 minutes Extra values in the range – lose final A mark.	A1
		(6)
		(13 marks)

Question Number	Scheme	Marks
10. (a)	$R = \sqrt{34}$	B1
	$\tan\alpha = \frac{5}{3}$	M1
	$\Rightarrow \alpha = 1.03$ awrt 1.03	A1
		[3]
(b)	$3\sin 2x + 5\cos 2x = 4 \Rightarrow \sqrt{34}\sin(2x + 1.03) = 4$	
	$\sin(2x + "1.03") = \frac{4}{"\sqrt{34}"}$ $(= 0.68599...)$	M1
	One solution in range Eg. $2x + "1.03" = 2\pi + \arcsin\left(\frac{4}{"\sqrt{34}"}\right) \Rightarrow x = ...$	M1
	Either $x =$ awrt 3.0 **or** awrt 0.68	A1
	Second solution in range Eg $2x + "1.03" = \pi - \arcsin\left(\frac{4}{"\sqrt{34}"}\right) \Rightarrow x = ...$	M1
	Both $x =$ awrt 2sf 3.0 **and** 0.68	A1
		[5]
(c)	Greatest value is $4\left(\sqrt{34}\right)^2 + 3 = 139$	M1 A1
	Least value is $4(0) + 3 = 3$.	M1 A1
		[4]
		(12 marks)

Question Number	Scheme	Notes	Marks
1.(a)	$R = \sqrt{34}$	Cao (Must be exact but score when first seen and ignore decimal value (5.83…))	B1
	$\tan\alpha = \pm\frac{5}{3}, \tan\alpha = \pm\frac{3}{5} \Rightarrow \alpha = ...$ (Allow $\cos\alpha = \pm\frac{5}{\sqrt{34}}$ or $\pm\frac{3}{\sqrt{34}}, \sin\alpha = \pm\frac{5}{\sqrt{34}}$ or $\pm\frac{3}{\sqrt{34}} \Rightarrow \alpha = ...$) Where $\sqrt{34}$ is their R		M1
	$\alpha = 59.04°$	awrt 59.04°	A1
			(3)
(b)	$\sqrt{34}\cos(\theta - 59.04) = 2 \Rightarrow \cos(\theta - 59.04) = \frac{2}{\sqrt{34}}(0.343)$ Attempts to use part (a) "$\sqrt{34}$" $\cos(\theta - $ "59.04") $= 2$ and proceeds to $\cos(\theta \pm$ "59.04") $= K$, $\lvert K\rvert$ „ 1 May be implied by $\theta -$ "59.04" $= 69.94…°$ or $\theta -$ "59.04" $\cos^{-1}\left(\frac{2}{\text{their}\sqrt{34}}\right)$ The $\theta -$ "59.04" must be seen here or implied later		M1
	$\theta_1 - 59.04 = 69.94 \Rightarrow \theta_1 =$ awrt 129.0°		A1
	$\theta_2 \pm 59.04 = 360 - '69.94' \Rightarrow \theta_2 = ...$ Correct attempt at a second solution in the range. It is **dependent** upon having scored the previous M. Usually for $\theta -$ their $59.04 = 360 -$ their $'69.94' \Rightarrow \theta = ...$		**d**M1
	$\theta_2 = 349.1°$	awrt 349.1°	A1
	For solutions in (b) that are otherwise fully correct, if there are extra answers in range, deduct the final A mark.		
			(4)
(c)	$\theta +$ their $59.04 = \cos^{-1}\left(\frac{2}{\text{their}\sqrt{34}}\right) \Rightarrow \theta = ...$ Allow $\theta -$ their $59.04 = \cos^{-1}\left(\frac{2}{\text{their}\sqrt{34}}\right) \Rightarrow \theta = ...$ if they have $\theta +$ .. in (b) Evidence that use is being made of parts (a) and (b) to obtain a value for θ. This can be implied by the use of their answers to part (b).		M1
	$\theta = 10.9°$	awrt 10.9	A1
			(2)
			(9 marks)

Qu	Scheme	Marks
11. (a)	$R = 37$	B1
	$\tan\alpha = \frac{12}{35} \Rightarrow \alpha = \text{awrt } 0.3303$	M1 A1
		(3)
(b)	$\sin(x-\alpha) = \frac{37}{2R} \quad (= 0.5...)$	M1
	$x = \arcsin\left(\frac{37}{2\times \text{their "37"}}\right) + \text{their"0.3303"}$	M1
	$x = \text{awrt } 0.854 \text{ or awrt } 2.95$	A1
	$x = \text{awrt } 0.854 \text{ and awrt } 2.95$	A1
		(4)
(c)(i)	Find $y = \frac{7000}{31+(\pm\text{"}R\text{"})^2} = 5$	M1 A1
(c)(ii)	$x-\alpha = \frac{\pi}{2} \Rightarrow x = 1.90$	M1 A1
		(4)
		(11 marks)

(a)

B1: $R = 37$ no working needed. Condone $R = \pm 37$

M1: $\tan\alpha = \pm\frac{12}{35}$ or $\tan\alpha = \pm\frac{35}{12}$ with an attempt to find alpha. Accept decimal attempts from $\tan\alpha = \text{awrt } \pm 0.343$ or $\tan\alpha = \text{awrt } \pm 2.92$ If R is used allow $\sin\alpha = \pm\frac{12}{R}$ OR $\cos\alpha = \pm\frac{35}{R}$ with an attempt to find alpha

A1: $\alpha = \text{awrt } 0.3303$. Answers in degrees are A0

(b)

M1: (Uses part (a) to solve equation) $\sin(x \pm \alpha) = \frac{37}{2\times theirR}$

M1: operations undone in the correct order to give $x =$... Accept $\sin(x \pm \alpha) = k \Rightarrow x = \arcsin k \pm \alpha$

A1: one correct answer to within required accuracy. Allow 0.272π or 0.938π.

Condone for this mark only **both** $\frac{\pi}{6} + 0.3303$ **and** $\frac{5\pi}{6} + 0.3303$

A1: both values (and no extra values in the range) correct to within required accuracy. Allow $0.272\pi, 0.938\pi$

(c) (i)

M1: For an attempt at $\frac{7000}{31+(\pm\text{"}R\text{"})^2}$

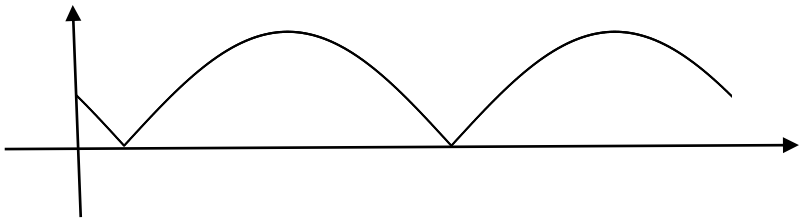
A1: 5

(c)(ii)

M1: Uses $x - \text{their } \alpha = (2n+1)\frac{\pi}{2}$ to find x This may be implied by $1.57 \pm \text{their } 0.33$ stated or calculated (2dp)

A1: Awrt 1.90 but condone 1.9 for this answer

Answers in degrees, withhold the first time seen, usually part (a). FYI (a) $18.92°$ (b) $48.9°, 168.9°$ (c)(ii) $108.9°$

Question Number	Scheme	Marks
10(a)	$R=\sqrt{5}$	B1
	$\tan\alpha=\frac{1}{2}\Rightarrow(\alpha=)26.6°$	M1,A1
		(3)
(b)	 Shape	B1
	$(0,1)$	B1
	$("26.6",0)$ and $("206.6",0)$ (Allow in radians i.e. their α and π+α	B1ft
		(3)
(c)(i)	$5+'R'=5+\sqrt{5}$	B1ft
(c)(ii)	$15t-'26.6'=270\Rightarrow t=19.8$	M1,A1
		(3)
		(9 marks)

(a)

B1: $R=\sqrt{5}$

M1: For $\tan\alpha=\pm\frac{1}{2}$ or $\tan\alpha=\pm\frac{2}{1}$ or $\sin\alpha=\pm\frac{1}{"\sqrt{5}"}$ or $\cos\alpha=\pm\frac{2}{"\sqrt{5}"}$

A1: Awrt $\alpha=26.6°$

(b)

B1: Correct shape including cusps. A curve that starts downwards from the positive *y*-axis with two maxima. This mark is essentially for realising that the parts of the curve under the *x*-axis are reflected in the *x*-axis and for cusps that look "pointed" and not rounded.

B1: $(0,1)$ may be seen on the diagram or in the body of the script as coordinates or seen as $x = 0$, $y = 1$. If there is any ambiguity, the sketch takes precedence. Allow (1, 0) as long as it is marked in the correct place on the sketch.

B1**ft**: $(26.6,0)$ and $(206.6,0)$ or their 26.6 and 180 + their 26.6. May be seen on the sketch or in the body of the script as coordinates or seen as $y = 0$, $\theta(\text{or } x)=26.6$, $\theta(\text{or } x)=206.6$. If there is any ambiguity, the sketch takes precedence. Allow awrt 26.6 and awrt 207 or their ft values.

(c)(i)

B1ft: Follow through on $5+'R'$ including decimal answers (NB 5 + √5 = 7.24…)

(c)(ii)

M1: Attempts $15t-"26.6"=90$ or $270\Rightarrow t=...$ (Allow π/2, 3π/2 for 90, 270 if working in radians)

A1: $t=19.8$ **only**

(c)(ii) Alternative:

$f(t)=5+2\sin(15t)-\cos(15t)\Rightarrow f'(t)=30\cos(15t)+15\sin(15t)$

M1: Attempts $f'(t)=0\Rightarrow 15t=180-63.43...$ or $360-63.43$

A1: $t=19.8$ **only**

Question Number	Scheme	Marks
4.(a)	$R=\sqrt{29}$	B1
	$\tan\alpha=\frac{2}{5}\Rightarrow\alpha=$ awrt 0.381	M1A1
		(3)
(b)	$5\cot 2x-3\text{cosec}\,2x=2\Rightarrow 5\frac{\cos 2x}{\sin 2x}-\frac{3}{\sin 2x}=2$	M1
	$\Rightarrow 5\cos 2x-2\sin 2x=3$	A1
		(2)
(c)	$5\cos 2x-2\sin 2x=3\Rightarrow\cos(2x+0.381)=\frac{3}{\sqrt{29}}$	M1
	$2x+0.381=\arccos\left(\frac{3}{\sqrt{29}}\right)\Rightarrow x=...$	dM1
	$x=$ awrt 0.30, 2.46	A1A1
		(4)
		(9 marks)
Alt I (c)	$5\cos 2x-2\sin 2x=3\Rightarrow 10\cos^2 x-5-4\sin x\cos x=3$	
	$\Rightarrow 4\tan^2 x+2\tan x-1=0$	M1
	$\Rightarrow\tan x=\frac{-1\pm\sqrt{5}}{4}\Rightarrow x=..$	dM1
	$x=$ awrt 0.30, 2.46	A1A1
		(4)
Alt II (c)	$5\cos 2x-2\sin 2x=3\Rightarrow(5\cos 2x)^2=(3+2\sin 2x)^2$ **&** $\cos^2 2x=1-\sin^2 2x$	
	$\Rightarrow 29\sin^2 2x+12\sin 2x-16=0$	M1
	$\Rightarrow\sin 2x=\frac{-12\pm\sqrt{2000}}{58}\Rightarrow 2x=..\Rightarrow x=..$	dM1
	$x=$ awrt 0.30, 2.46	A1A1
		(4)

(a)

B1 $R=\sqrt{29}$

Condone $R=\pm\sqrt{29}$ (Do not allow decimals for this mark Eg 5.39 but remember to isw after $\sqrt{29}$)

M1 $\tan\alpha=\pm\frac{2}{5},\ \tan\alpha=\pm\frac{5}{2}\Rightarrow\alpha=...$

If R is used to find α accept $\sin\alpha=\pm\frac{2}{R}$ or $\cos\alpha=\pm\frac{5}{R}\Rightarrow\alpha=...$

Question	Scheme	Marks
3.(a)	$R=\sqrt{5}$	B1
	$\tan\alpha=\frac{1}{2}\Rightarrow\alpha=26.57°$	M1A1
		(3)
(b)	$\frac{2}{2\cos\theta-\sin\theta-1}=15\Rightarrow\frac{2}{\sqrt{5}\cos(\theta+26.6°)-1}=15$	
	$\Rightarrow\cos(\theta+26.6°)=\frac{17}{15\sqrt{5}}=(awrt\ 0.507)$	M1A1
	$\theta+26.57°=59.54°$	
	$\Rightarrow\theta=awrt\ 33.0°$ or $awrt\ 273.9°$	A1
	$\theta+26.6°=360°-$ their $'59.5°'$	dM1
	$\Rightarrow\theta=awrt\ 273.9°$ and $awrt\ 33.0°$	A1
		(5)
(c)	$\theta-$ their $26.57°=$ their $59.54°\Rightarrow\theta=...$	M1
	$\theta=$ awrt $86.1°$	A1
		(2)
		(10 marks)

(a)

B1 $R=\sqrt{5}$. Condone $R=\pm\sqrt{5}$ Ignore decimals

M1 $\tan\alpha=\pm\frac{1}{2}$, $\tan\alpha=\pm\frac{2}{1}\Rightarrow\alpha=...$

If their value of R is used to find the value of α only accept $\cos\alpha=\pm\frac{2}{R}$ OR $\sin\alpha=\pm\frac{1}{R}\Rightarrow\alpha=...$

A1 $\alpha=$ awrt $26.57°$

(b)

M1 Attempts to use part (a) $\Rightarrow\cos(\theta\pm\text{their } 26.6°)=K$, $|K|\,,,\,1$

A1 $\cos(\theta\pm\text{their } 26.6°)=\frac{17}{15\sqrt{5}}=(\text{awrt } 0.507)$. Can be implied by $(\theta\pm\text{their } 26.6°)=\text{awrt } 59.5°/59.6°$

A1 One solution correct, $\theta=awrt\ 33.0°$ or $\theta=awrt\ 273.9°$ Do not accept 33 for 33.0.

dM1 Obtains a second solution in the range. It is dependent upon having scored the previous M.
Usually for $\theta\pm\text{their } 26.6°=360°-\text{their } 59.5°\Rightarrow\theta=...$

A1 Both solutions $\theta=awrt\ 33.0°$ and a$wrt\ 273.9°$. Do not accept 33 for 33.0.
Extra solutions inside the range withhold this A1. Ignore solutions outside the range $0\,,,\,\theta<360°$

(c)

M1 $\theta-$ their $26.57°=$ their $59.54°\Rightarrow\theta=...$
Alternatively $-\theta+$ their $26.6°=-$their $59.5°\Rightarrow\theta=...$
If the candidate has an incorrect sign for α, for example they used $\cos(\theta-26.57°)$ in part (b) it would be scored for $\theta+$ their $26.57°=$ their $59.54°\Rightarrow\theta=...$

A1 awrt $86.1°$ ONLY. Allow both marks following a correct (a) and (b)
They can restart the question to achieve this result. Do not award if 86.1 was their smallest answer in (b). This occurs when they have $\cos(\theta-26.57°)$ instead of $\cos(\theta+26.57°)$ in (b)

Answers in radians: Withhold only one A mark, the first time a solution in radians appears
FYI (a) $\alpha=0.46$ (b) $\theta_1=$ awrt 0.58 and $\theta_2=$ awrt 4.78 (c) $\theta_3=$ awrt 1.50. Require 2 dp accuracy

Question Number	Scheme	Marks
3(a)	$4\cos 2\theta + 2\sin 2\theta = R\cos(2\theta - \alpha)$	
	$R = \sqrt{4^2 + 2^2} = \sqrt{20} = \left(2\sqrt{5}\right)$	B1
	$\alpha = \arctan\left(\frac{1}{2}\right) = 26.565°... = \text{awrt } 26.57°$	M1A1
		(3)
(b)	$\sqrt{20}\cos(2\theta - 26.6) = 1 \Rightarrow \cos(2\theta - 26.57) = \frac{1}{\sqrt{20}}$	M1
	$\Rightarrow (2\theta - 26.57) = +77.1.. \Rightarrow \theta = ...$	dM1
	$\theta = \text{awrt } 51.8°$	A1
	$2\theta - 26.57 = '-77.1...' \Rightarrow \theta = -\text{awrt } 25.3°$	ddM1A1
		(5)
(c)	$k < -\sqrt{20}, k > \sqrt{20}$	B1ft either B1ft both
		(2)
		(10 marks)

You can marks parts (a) and (b) together as one.

(a)

B1 For $R = \sqrt{20} = 2\sqrt{5}$. Condone $R = \pm\sqrt{20}$

M1 For $\alpha = \arctan\left(\pm\frac{1}{2}\right)$ or $\alpha = \arctan(\pm 2)$ leading to a solution of α

Condone any solutions coming from $\cos\alpha = 4, \sin\alpha = 2$

Condone for this mark $2\alpha = \arctan\left(\pm\frac{1}{2}\right) \Rightarrow \alpha = ..$

If R has been used to find α award for only $\alpha = \arccos\left(\pm\frac{4}{'R'}\right)$ $\alpha = \arcsin\left(\pm\frac{2}{'R'}\right)$

A1 $\alpha = \text{awrt } 26.57°$

Question Number	Scheme	Marks
7.(a)	$R=\sqrt{\left(6^2+2.5^2\right)}=6.5$	B1
	$\tan\alpha=\dfrac{2.5}{6},\quad\Rightarrow\quad\alpha=$ awrt 0.395	M1A1
		(3)
(b)	$(0,6)$,	B1
	awrt $(1.97,0)\quad(5.11,0)$	M1A1
		(3)
(c)	$H_{\max}=18.5, H_{\min}=5.5$	M1A1A1
		(3)
(d)	Sub $H=16$ and proceed to $'6.5'\cos\left(\dfrac{2\pi t}{52}\pm'0.395'\right)=4$	M1
	$\left(\dfrac{2\pi t}{52}-'0.395'\right)=$ awrt 0.91	A1
	$t=\left(awrt\,0.908\pm'0.395'\right)\times\dfrac{52}{2\pi}=11\ (10.78)$	dM1A1
	$\left(\dfrac{2\pi t}{52}\pm'0.395'\right)=awrt\,2\pi-0.908\Rightarrow t=48\ (47.75)$	ddM1A1
		(6)
		(15 marks)

(a)

B1 $R=6.50,\dfrac{13}{2}$. Accept $R=$ awrt 6.50. Do not accept $R=\pm6.50$

M1 For reaching $\tan\alpha=\pm\dfrac{2.5}{6}$ *or* $\tan\alpha=\pm\dfrac{6}{2.5}$.

If R has been attempted first then only accept $\sin\alpha=\pm\dfrac{2.5}{'R'}$ *or* $\cos\alpha=\pm\dfrac{6}{'R'}$

A1 Correct value $\alpha=awrt\ 0.395$. The answer in degrees $22.6°$ is A0

(b)

B1 The correct y intercept. Accept $y=6,(0,6)$, awrt y = 6.00, $f(0)=6$ or it marked on the curve.
Do not accept $(6,0)$

M1 Attempt to find either *x* intercept from $\dfrac{\pi}{2}+$ their 0.395, or $\dfrac{3\pi}{2}+$ their 0.395

If the candidate is working in degrees accept $90+$ their 22.6 or $270+$ their 22.6
One answer correct will imply this.

A1 Both answers correct. Accept awrt $(1.97,0)$ and $(5.11,0)$, Accept $x=1.97$ and $x=5.11$ or both being marked on the curve. Do not accept $(0,1.97)$ and $(0,5.11)$ for both marks
In degrees accept $(112.6,0)$ and $(292.6,0)$

Question Number	Scheme	Marks
9.(a)	$R = \sqrt{20}$	B1
	$\tan\alpha = \frac{4}{2} \Rightarrow \alpha = \text{awrt } 1.107$	M1A1 (3)
(b)(i)	$'4 + 5R^2' = 104$	B1ft
(ii)	$3\theta - '1.107' = \frac{\pi}{2} \Rightarrow \theta = \text{awrt } 0.89$	M1A1 (3)
(c)(i)	4	B1
(ii)	$3\theta - '1.107' = 2\pi \Rightarrow \theta = \text{awrt } 2.46$	M1A1 (3) **(9 marks)**

Question Number	Scheme	Marks
8(a)	$R = \sqrt{\left(7^2 + 24^2\right)} = 25$	B1
	$\tan\alpha = \frac{24}{7}, \quad \Rightarrow \quad \alpha = \text{awrt } 73.74°$	M1A1 **(3)**
(b)	maximum value of $24\sin x + 7\cos x = 25$ so $V_{\min} = \frac{21}{25} = (0.84)$	M1A1 **(2)**
(c)	Distance $AB = \frac{7}{\sin\theta}$, with $\theta = \alpha$	M1, B1
	So distance = 7.29m $= \frac{175}{24}$m	A1 **(3)**
(d)	$R\cos(\theta - \alpha) = \frac{21}{1.68} \Rightarrow \cos(\theta - \alpha) = 0.5$	M1, A1
	$\theta - \alpha = 60 \Rightarrow \theta = .., \theta - \alpha = -60 \Rightarrow \theta = ..$	dM1, dM1
	$\theta = \text{awrt } 133.7, 13.7$	A1, A1 **(6)** **(14 marks)**

Notes for Question 8

(a)

B1 25. Accept 25.0 but not $\sqrt{625}$ or answers that are not exactly 25. Eg 25.0001

M1 For $\tan\alpha = \pm\frac{24}{7}, \tan\alpha = \pm\frac{7}{24}$.

If the value of R is used only accept $\sin\alpha = \pm\frac{24}{R}, \cos\alpha = \pm\frac{7}{R}$

A1 Accept answers which round to 73.74 – must be in degrees for this mark

(b)

M1 Calculates $V = \frac{21}{their\ 'R'}$ NOT - R

A1 Obtains correct answer. $V = \frac{21}{25}$ Accept 0.84

Do not accept if you see incorrect working- ie from $\cos(\theta - \alpha) = -1$ or the minus just disappearing from a previous line.

Questions involving differentiation are acceptable. To score M1 the candidate would have to differentiate V by the quotient rule (or similar) , set V'=0 to find θ and then sub this back into V to find its value.

Question Number	Scheme	Marks
4.	(a) $R^2 = 6^2 + 8^2 \Rightarrow R = 10$	M1A1
	$\tan\alpha = \frac{8}{6} \Rightarrow \alpha =$ awrt 0.927	M1A1 (4)
	(b)(i) $\mathrm{p}(x) = \frac{4}{12 + 10\cos(\theta - 0.927)}$	
	$\mathrm{p}(x) = \frac{4}{12 - 10}$	M1
	Maximum = 2	A1 (2)
	(b)(ii) $\theta - 'their\,\alpha' = \pi$	M1
	$\theta =$ awrt 4.07	A1 (2) **(8 marks)**

(a) M1 Using Pythagoras' Theorem with 6 and 8 to find R. Accept $R^2 = 6^2 + 8^2$
If α has been found first accept $R = \pm\frac{8}{\sin'\alpha'}$ or $R = \pm\frac{6}{\cos'\alpha'}$

A1 $R = 10$. Many candidates will just write this down which is fine for the 2 marks.
Accept ± 10 but not -10

M1 For $\tan\alpha = \pm\frac{8}{6}$ or $\tan\alpha = \pm\frac{6}{8}$
If R is used then only accept $\sin\alpha = \pm\frac{8}{R}$ or $\cos\alpha = \pm\frac{6}{R}$

A1 $\alpha =$ awrt 0.927 . Note that 53.1^0 is A0

(b) Note that (b)(i) and (b)(ii) can be marked together

(i) M1 Award for $\mathrm{p}(x) = \frac{4}{12 - 'R'}$.

A1 Cao $\mathrm{p}(x)_{\max} = 2$.
The answer is acceptable for both marks as long as no incorrect working is seen

(ii) M1 For setting $\theta - 'their\,\alpha' = \pi$ and proceeding to θ=..
If working exclusively in degrees accept $\theta - 'their\,\alpha' = 180$
Do not accept mixed units

A1 $\theta =$ awrt 4.07 . If the final A mark in part (a) is lost for 53.1, then accept awrt 233.1