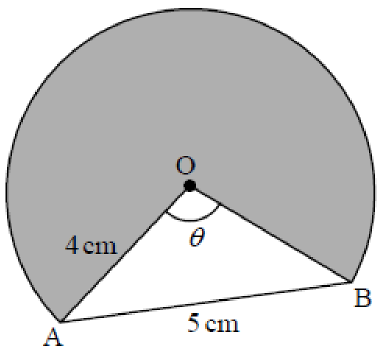
Revision Trigonometry *[213 marks]*

The following diagram shows part of a circle with centre O and radius 4 cm.



Chord AB has a length of 5 cm and AÔB = θ.

1a. Find the value of θ, giving your answer in radians. *[3 marks]*

Markscheme

METHOD 1

attempt to use the cosine rule ***(M1)***

$\cos\theta = \frac{4^2+4^2-5^2}{2\times4\times4}$ (or equivalent) ***A1***

$\theta = 1.35$ ***A1***

METHOD 2

attempt to split triangle AOB into two congruent right triangles ***(M1)***

$\sin\left(\frac{\theta}{2}\right) = \frac{2.5}{4}$ ***A1***

$\theta = 1.35$ ***A1***

[3 marks]

1b. Find the area of the shaded region. *[3 marks]*

Markscheme

attempt to find the area of the shaded region ***(M1)***

$\frac{1}{2} \times 4 \times 4 \times (2\pi - 1.35\ldots)$ ***A1***

= 39.5 (cm^2) ***A1***

[3 marks]

Consider a function f, such that $f\left(x\right) = 5.8\sin\left(\frac{\pi}{6}(x+1)\right) + b$, 0 ≤ x ≤ 10, $b \in \mathbb{R}$.

2a. Find the period of f. *[2 marks]*

Markscheme

correct approach ***A1***

eg $\frac{\pi}{6} = \frac{2\pi}{period}$ (or equivalent)

period = 12 ***A1***

[2 marks]

The function f has a local maximum at the point (2, 21.8) , and a local minimum at (8, 10.2).

2b. Find the value of b. *[2 marks]*

Markscheme

valid approach ***(M1)***

eg $\frac{\max+\min}{2}$ $b = \max - \text{amplitude}$

$\frac{21.8+10.2}{2}$, or equivalent

b = 16 ***A1***

[2 marks]

2c. Hence, find the value of f(6). *[2 marks]*

Markscheme

attempt to substitute into **their** function ***(M1)***

$5.8\sin\left(\frac{\pi}{6}(6+1)\right)+16$

f(6) = 13.1 ***A1***

[2 marks]

A second function g is given by $g(x) = p\sin\left(\frac{2\pi}{9}(x-3.75)\right)+q$, 0 ≤ x ≤ 10; p, $q \in \mathbb{R}$.

The function g passes through the points (3, 2.5) and (6, 15.1).

2d. Find the value of p and the value of q. *[5 marks]*

Markscheme

valid attempt to set up a system of equations ***(M1)***

two correct equations ***A1***

$p\sin\left(\frac{2\pi}{9}(3-3.75)\right)+q=2.5,\ p\sin\left(\frac{2\pi}{9}(6-3.75)\right)+q=15.1$

valid attempt to solve system ***(M1)***

p = 8.4; q = 6.7 ***A1A1***

[5 marks]

2e. Find the value of x for which the functions have the greatest difference. *[2 marks]*

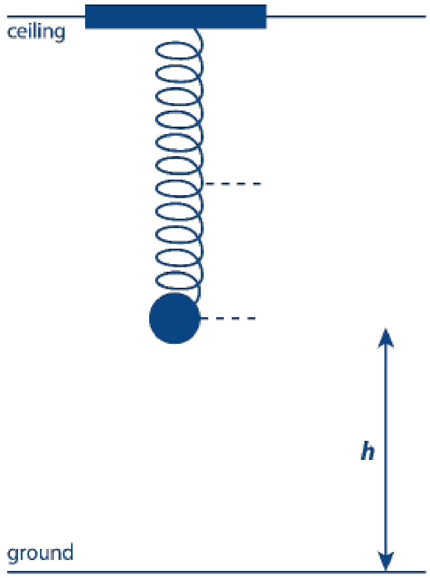
Markscheme

attempt to use $|f(x)-g(x)|$ to find maximum difference ***(M1)***

x = 1.64 ***A1***

[2 marks]

The following diagram shows a ball attached to the end of a spring, which is suspended from a ceiling.



The height, h metres, of the ball above the ground at time t seconds after being released can be modelled by the function $h(t) = 0.4\cos(\pi t) + 1.8$ where $t \geq 0$.

3a. Find the height of the ball above the ground when it is released. *[2 marks]*

Markscheme

* This sample question was produced by experienced DP mathematics senior examiners to aid teachers in preparing for external assessment in the new MAA course. There may be minor differences in formatting compared to formal exam papers.

attempts to find $h(0)$ **(M1)**

$h(0) = 0.4\cos(0) + 1.8 (= 2.2)$

2.2 (m) (above the ground) **A1**

[2 marks]

3b. Find the minimum height of the ball above the ground. *[2 marks]*

Markscheme

EITHER

uses the minimum value of $\cos(\pi t)$ which is -1 **M1**

$0.4(-1)+1.8$ (m)

OR

the amplitude of motion is 0.4 (m) and the mean position is 1.8 (m) **M1**

OR

finds $h'(t) = -0.4\pi\sin(\pi t)$, attempts to solve $h'(t) = 0$ for t and determines that the minimum height above the ground occurs at $t = 1,\ 3,\ \ldots$ **M1**

$0.4(-1)+1.8$ (m)

THEN

1.4 (m) (above the ground) **A1**

[2 marks]

3c. Show that the ball takes 2 seconds to return to its initial height above the ground for the first time. *[2 marks]*

Markscheme

EITHER

the ball is released from its maximum height and returns there a period later **R1**

the period is $\frac{2\pi}{\pi}(=2)(\mathrm{s})$ **A1**

OR

attempts to solve $h(t) = 2.2$ for t **M1**

$\cos(\pi t) = 1$

$t = 0,\ 2,\ \ldots$ **A1**

THEN

so it takes 2 seconds for the ball to return to its initial position for the first time **AG**

[2 marks]

3d. For the first 2 seconds of its motion, determine the amount of time that the ball is less than $1.8 + 0.2\sqrt{2}$ metres above the ground. *[5 marks]*

Markscheme

$0.4\cos(\pi t) + 1.8 = 1.8 + 0.2\sqrt{2}$ **(M1)**

$0.4\cos(\pi t) = 0.2\sqrt{2}$

$\cos(\pi t) = \frac{\sqrt{2}}{2}$ **A1**

$\pi t = \frac{\pi}{4},\ \frac{7\pi}{4}$ **(A1)**

Note: Accept extra correct positive solutions for πt.

$t = \frac{1}{4},\ \frac{7}{4} (0 \le t \le 2)$ **A1**

Note: Do not award **A1** if solutions outside $0 \le t \le 2$ are also stated.

the ball is less than $1.8 + 0.2\sqrt{2}$ metres above the ground for $\frac{7}{4} - \frac{1}{4}$ (s)

1.5 (s) **A1**

[5 marks]

Consider $f(x) = 4\sin x + 2.5$ and $g(x) = 4\sin\left(x - \frac{3\pi}{2}\right) + 2.5 + q$, where $x \in \mathbb{R}$ and $q > 0$.

The graph of g is obtained by two transformations of the graph of f.

4a. Describe these two transformations. *[2 marks]*

Markscheme

translation (shift) by $\frac{3\pi}{2}$ to the right/positive horizontal direction ***A1***

translation (shift) by q upwards/positive vertical direction ***A1***

Note: accept translation by $\begin{pmatrix} \frac{3\pi}{2} \\ q \end{pmatrix}$

Do not accept ‘move’ for translation/shift.

[2 marks]

4b. The y-intercept of the graph of g is at $(0,\ r)$. *[5 marks]*

Given that $g(x) \geq 7$, find the smallest value of r.

Markscheme

METHOD 1

minimum of $4\sin\left(x-\frac{3\pi}{2}\right)$ is -4 (may be seen in sketch) ***(M1)***

$-4+2.5+q\geq 7$

$q\geq 8.5$ (accept $q=8.5$) ***A1***

substituting $x=0$ and their $q\ (=8.5)$ to find r ***(M1)***

$(r=)\ 4\sin\left(\frac{-3\pi}{2}\right)+2.5+8.5$

$4+2.5+8.5$ ***(A1)***

smallest value of r is 15 ***A1***

METHOD 2

substituting $x=0$ to find an expression (for r) in terms of q ***(M1)***

$(g(0)=r=)\ 4\sin\left(\frac{-3\pi}{2}\right)+2.5+q$

$(r=)\ 6.5+q$ ***A1***

minimum of $4\sin\left(x-\frac{3\pi}{2}\right)$ is -4 ***(M1)***

$-4+2.5+q\geq 7$

$-4+2.5+(r-6.5)\geq 7$ (accept $=$) ***(A1)***

smallest value of r is 15 ***A1***

METHOD 3

$4\sin\left(x-\frac{3\pi}{2}\right)+2.5+q=4\cos x+2.5+q$ ***A1***

y-intercept of $4\cos x+2.5+q$ is a maximum ***(M1)***

amplitude of $g(x)$ is 4 ***(A1)***

attempt to find least maximum ***(M1)***

$r=2\times 4+7$

smallest value of r is 15 ***A1***

[5 marks]

5. Find the least positive value of x for which $\cos\left(\frac{x}{2}+\frac{\pi}{3}\right)=\frac{1}{\sqrt{2}}$. *[5 marks]*

Markscheme

determines $\frac{\pi}{4}$ (or 45°) as the first quadrant (reference) angle ***(A1)***

attempts to solve $\frac{x}{2}+\frac{\pi}{3}=\frac{\pi}{4}$ ***(M1)***

Note: Award ***M1*** for attempting to solve $\frac{x}{2}+\frac{\pi}{3}=\frac{\pi}{4},\frac{7\pi}{4}(,\ldots)$

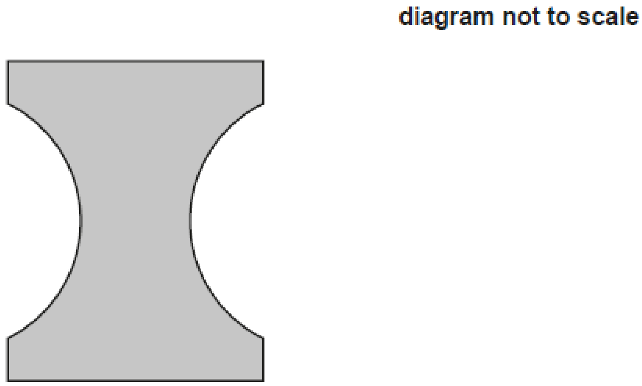
$\frac{x}{2}+\frac{\pi}{3}=\frac{\pi}{4}\Rightarrow x<0$ and so $\frac{\pi}{4}$ is rejected ***(R1)***

$\frac{x}{2}+\frac{\pi}{3}=2\pi-\frac{\pi}{4}\left(=\frac{7\pi}{4}\right)$ ***A1***

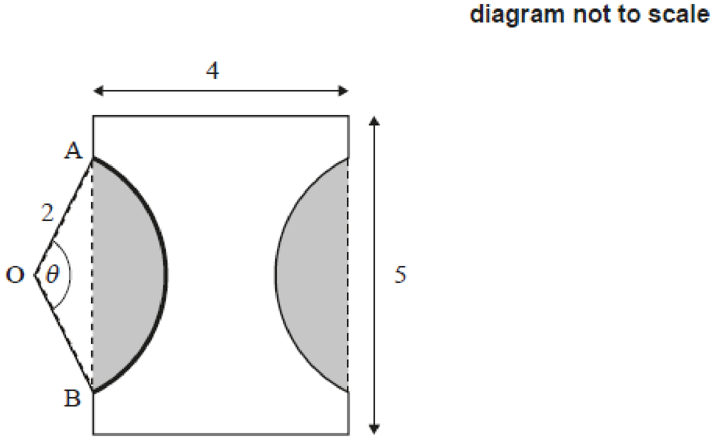
$x=\frac{17\pi}{6}$ (must be in radians) ***A1***

[5 marks]

A company is designing a new logo. The logo is created by removing two equal segments from a rectangle, as shown in the following diagram.



The rectangle measures $5\ \mathrm{cm}$ by $4\ \mathrm{cm}$. The points A and B lie on a circle, with centre O and radius $2\ \mathrm{cm}$, such that $\mathrm{A\hat{O}B} = \theta$, where $0 < \theta < \pi$. This information is shown in the following diagram.



6a. Find the area of one of the shaded segments in terms of θ. *[3 marks]*

Markscheme

valid approach to find area of segment by finding area of sector – area of triangle ***(M1)***

$\frac{1}{2}r^2\theta - \frac{1}{2}r^2 \sin\theta$

$\frac{1}{2}(2)^2\theta - \frac{1}{2}(2)^2 \sin\theta$ ***(A1)***

area $= 2\theta - 2\sin\theta$ ***A1***

[3 marks]

6b. Given that the area of the logo is $13.4\ \mathrm{cm}^2$, find the value of θ. *[3 marks]*

Markscheme

EITHER

area of logo = area of rectangle – area of segments ***(M1)***

$5 \times 4 - 2 \times (2\theta - 2\sin\theta) = 13.4$ ***(A1)***

OR

area of one segment $= \frac{20-13.4}{2}\ (= 3.3)$ ***(M1)***

$2\theta - 2\sin\theta = 3.3$ ***(A1)***

THEN

$\theta = 2.35672\ldots$

$\theta = 2.36$ (do not accept an answer in degrees) ***A1***

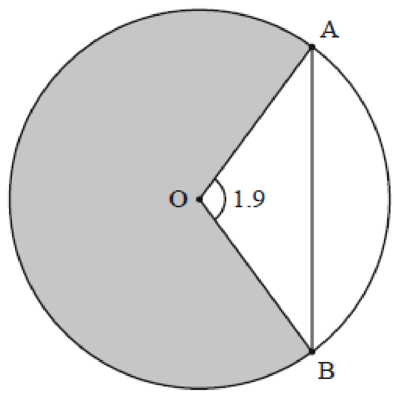
Note: Award ***(M1)(A1)A0*** if there is more than one solution.
Award ***(M1)(A1FT)A0*** if the candidate works in degrees and obtains a final answer of $135.030\ldots$

[3 marks]

The following diagram shows a circle with centre O and radius 5 metres.

Points A and B lie on the circle and $\mathrm{A\hat{O}B} = 1.9$ radians.

diagram not to scale



7a. Find the length of the chord $[\mathrm{AB}]$. *[3 marks]*

Markscheme

EITHER

uses the cosine rule ***(M1)***

$\mathrm{AB}^2 = 5^2 + 5^2 - 2 \times 5 \times 5 \times \cos 1.9$ ***(A1)***

OR

uses right-angled trigonometry ***(M1)***

$\frac{\frac{\mathrm{AB}}{2}}{5} \sin 0.95$ ***(A1)***

OR

uses the sine rule ***(M1)***

$\alpha = \frac{1}{2}(\pi - 1.9)(= 0.6207\ldots)$

$\frac{\mathrm{AB}}{\sin 1.9} = \frac{5}{\sin 0.6207\ldots}$ ***(A1)***

THEN

$\mathrm{AB} = 8.13415\ldots$

$\mathrm{AB} = 8.13\,(\mathrm{m})$ ***A1***

[3 marks]

7b. Find the area of the shaded sector. *[3 marks]*

Markscheme

let the shaded area be A

METHOD 1

attempt at finding reflex angle ***(M1)***

$\mathrm{A\widehat{O}B} = 2\pi - 1.9\ (= 4.3831\ldots)$

substitution into area formula ***(A1)***

$A = \frac{1}{2} \times 5^2 \times 4.3831\ldots$ OR $\left(\frac{2\pi - 1.9}{2\pi}\right) \times \pi \left(5^2\right)$

$= 54.7898\ldots$

$= 54.8\left(\mathrm{m}^2\right)$ ***A1***

METHOD 2

let the area of the circle be A_C and the area of the unshaded sector be A_U

$A = A_C - A_U$ ***(M1)***

$A = \pi \times 5^2 - \frac{1}{2} \times 5^2 \times 1.9\ \left(= 78.5398\ldots - 23.75\right)$ ***(A1)***

$= 54.7898\ldots$

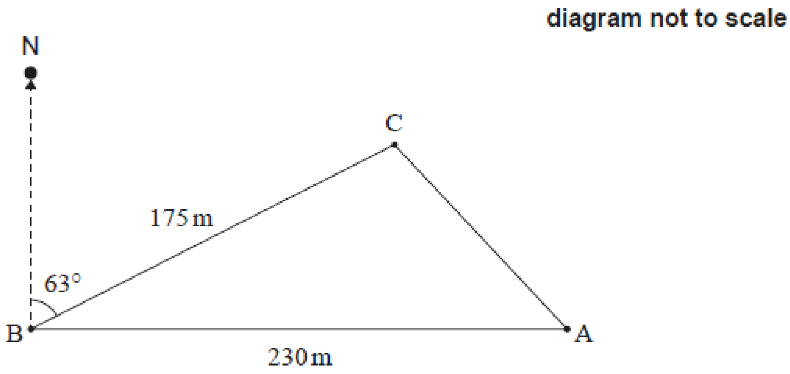
$= 54.8\left(\mathrm{m}^2\right)$ ***A1***

[3 marks]

A farmer is placing posts at points A, B, and C in the ground to mark the boundaries of a triangular piece of land on his property.

From point A, he walks due west 230 metres to point B.
From point B, he walks 175 metres on a bearing of 063° to reach point C.

This is shown in the following diagram.



8a. Find the distance from point A to point C. *[4 marks]*

Markscheme

$\mathrm{A\hat{B}C} = 27^\circ$ ***(A1)***

attempt to substitute into cosine rule ***(M1)***

$175^2 + 230^2 - 2(175)(230)\cos 27^\circ$ ***(A1)***

$108.62308\ldots$

$\mathrm{AC} = 109\,(\mathrm{m})$ ***A1***

[4 marks]

8b. Find the area of this piece of land. *[2 marks]*

Markscheme

correct substitution into area formula ***(A1)***

$\frac{1}{2} \times 175 \times 230 \times \sin 27^\circ$

$9136.55\ldots$

area $= 9140\left(\mathrm{m}^2\right)$ ***A1***

[2 marks]

8c. Find $\mathrm{C\hat{A}B}$. *[3 marks]*

Markscheme

attempt to substitute into sine rule or cosine rule ***(M1)***

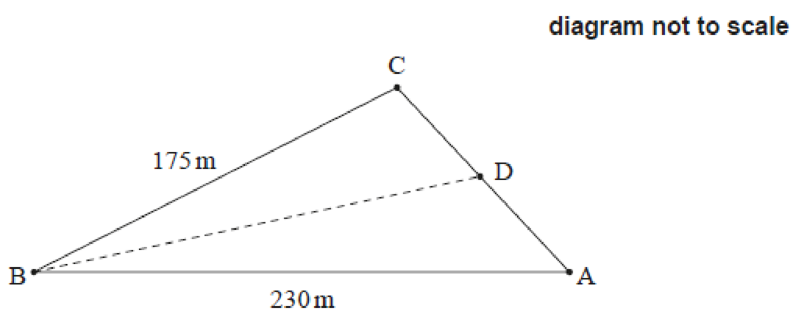
$\frac{\sin 27^\circ}{108.623\ldots} = \frac{\sin \hat{\mathrm{A}}}{175}$ OR $\cos \mathrm{A} = \frac{(108.623\ldots)^2 + 230^2 - 175^2}{2 \times 108.623\ldots \times 230}$ ***(A1)***

$47.0049\ldots$

$\mathrm{C\hat{A}B} = 47.0^\circ$ ***A1***

[3 marks]

The farmer wants to divide the piece of land into two sections. He will put a post at point D, which is between A and C. He wants the boundary BD to divide the piece of land such that the sections have equal area. This is shown in the following diagram.



8d. Find the distance from point B to point D. *[5 marks]*

Markscheme

METHOD 1

recognizing that for areas to be equal, $\mathrm{AD}=\mathrm{DC}$ ***(M1)***

$\mathrm{AD}=\frac{1}{2}\mathrm{AC}=54.3115\ldots$ ***A1***

attempt to substitute into cosine rule to find BD ***(M1)***

correct substitution into cosine rule ***(A1)***

$\mathrm{BD}^2=230^2+54.3115^2-2(230)(54.3115)\cos 47.0049^\circ$

$\mathrm{BD}=197.009\ldots$

$\mathrm{BD}=197\,(\mathrm{m})$ ***A1***

METHOD 2

correct expressions for areas of triangle BDA and triangle BCD using BD ***A1***

$\frac{1}{2}\times\mathrm{BD}\times 230\times\sin x^\circ$ and $\frac{1}{2}\times\mathrm{BD}\times 175\times\sin(27-x)^\circ$ OR

$\frac{1}{2}\times\mathrm{BD}\times 230\times\sin(27-x)^\circ$ and $\frac{1}{2}\times\mathrm{BD}\times 175\times\sin x^\circ$

correct equation in terms of x ***(A1)***

$175\sin(27-x)=230\sin x$ or $175\sin x=230\sin(27-x)$

$x=11.6326\ldots$ or $x=15.3673\ldots$ ***(A1)***

substituting their value of x into equation to solve for BD ***(M1)***

$\frac{1}{2}\times\mathrm{BD}\times 230\times\sin 11.6326\ldots=\frac{1}{2}\times\mathrm{BD}\times 175\times\sin 15.3673\ldots$ or

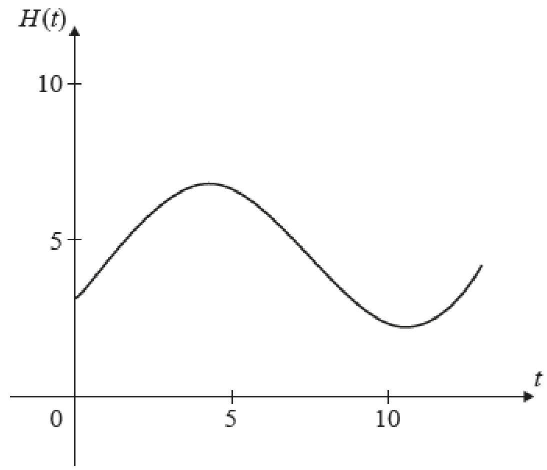
$\frac{1}{2}\times\mathrm{BD}\times 230\times\sin 11.6326\ldots=\frac{1}{2}\times 9136.55\ldots$

$\mathrm{BD}=197\,(\mathrm{m})$ ***A1***

[5 marks]

The height of water, in metres, in Dungeness harbour is modelled by the function $H(t) = a\sin(b(t-c)) + d$, where t is the number of hours after midnight, and $a,\ b,\ c$ and d are constants, where $a > 0,\ b > 0$ and $c > 0$.

The following graph shows the height of the water for 13 hours, starting at midnight.



The first high tide occurs at $04:30$ and the next high tide occurs 12 hours later. Throughout the day, the height of the water fluctuates between $2.2\ \mathrm{m}$ and $6.8\ \mathrm{m}$.

All heights are given correct to one decimal place.

9a. Show that $b = \frac{\pi}{6}$. *[1 mark]*

Markscheme

$12 = \frac{2\pi}{b}$ OR $b = \frac{2\pi}{12}$ ***A1***

$b = \frac{\pi}{6}$ ***AG***

[1 mark]

9b. Find the value of a. *[2 marks]*

Markscheme

$a = \frac{6.8-2.2}{2}$ OR $a = \frac{\max - \min}{2}$ ***(M1)***

$= 2.3\,(\mathrm{m})$ ***A1***

[2 marks]

9c. Find the value of d. *[2 marks]*

Markscheme

$d = \frac{6.8+2.2}{2}$ OR $d = \frac{\max+\min}{2}$ ***(M1)***

$= 4.5\,(\mathrm{m})$ ***A1***

[2 marks]

9d. Find the smallest possible value of c. *[3 marks]*

Markscheme

METHOD 1

substituting $t = 4.5$ and $H = 6.8$ for example into their equation for H ***(A1)***

$6.8 = 2.3\sin\left(\frac{\pi}{6}(4.5 - c)\right) + 4.5$

attempt to solve their equation ***(M1)***

$c = 1.5$ ***A1***

METHOD 2

using horizontal translation of $\frac{12}{4}$ ***(M1)***

$4.5 - c = 3$ ***(A1)***

$c = 1.5$ ***A1***

METHOD 3

$H'(t) = (2.3)\left(\frac{\pi}{6}\right)\cos\left(\frac{\pi}{6}(t - c)\right)$ ***(A1)***

attempts to solve their $H'(4.5) = 0$ for c ***(M1)***

$(2.3)\left(\frac{\pi}{6}\right)\cos\left(\frac{\pi}{6}(4.5 - c)\right) = 0$

$c = 1.5$ ***A1***

[3 marks]

9e. Find the height of the water at $12:00$. *[2 marks]*

Markscheme

attempt to find H when $t = 12$ or $t = 0$, graphically or algebraically ***(M1)***

$H = 2.87365\ldots$

$H = 2.87\,(\mathrm{m})$ ***A1***

[2 marks]

9f. Determine the number of hours, over a 24-hour period, for which the tide is higher than 5 metres. *[3 marks]*

Markscheme

attempt to solve $5 = 2.3\sin\left(\frac{\pi}{6}(t-1.5)\right)+4.5$ ***(M1)***

times are $t = 1.91852\ldots$ and $t = 7.08147\ldots$, $(t = 13.9185\ldots,\ t = 19.0814\ldots)$ ***(A1)***

total time is $2 \times (7.081\ldots - 1.919\ldots)$

$10.3258\ldots$

$= 10.3$ (hours) ***A1***

Note: Accept 10.

[3 marks]

10. Solve the equation $2\cos^2 x + 5\sin x = 4, 0 \le x \le 2\pi$. *[7 marks]*

Markscheme

attempt to use $\cos^2 x = 1 - \sin^2 x$ ***M1***

$2\sin^2 x - 5\sin x + 2 = 0$ ***A1***

EITHER

attempting to factorise ***M1***

$(2\sin x - 1)(\sin x - 2)$ ***A1***

OR

attempting to use the quadratic formula ***M1***

$\sin x = \frac{5 \pm \sqrt{5^2 - 4\times2\times2}}{4} \left(= \frac{5\pm3}{4}\right)$ ***A1***

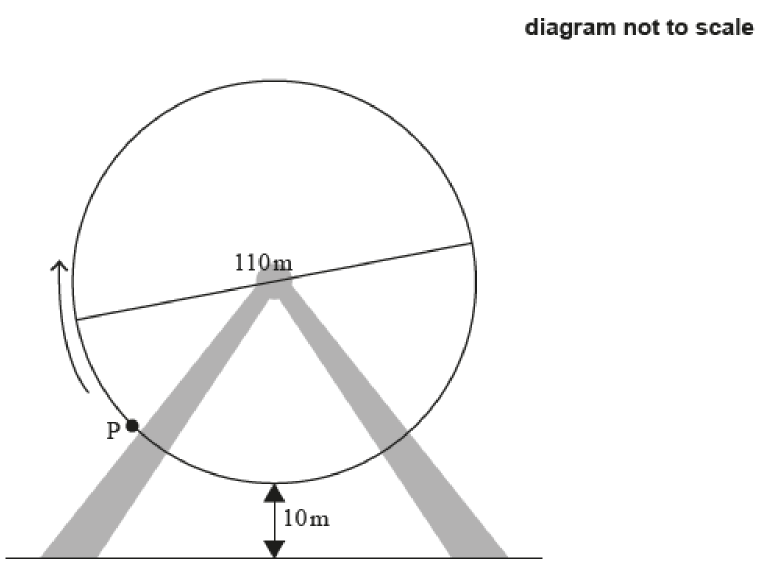
THEN

$\sin x = \frac{1}{2}$ ***(A1)***

$x = \frac{\pi}{6}, \frac{5\pi}{6}$ ***A1A1***

[7 marks]

11. A Ferris wheel with diameter 110 metres rotates at a constant speed. The lowest point on the wheel is 10 metres above the ground, as shown on the following diagram. P is a point on the wheel. The wheel starts moving with P at the lowest point and completes one revolution in 20 minutes. *[5 marks]*



The height, h metres, of P above the ground after t minutes is given by $h(t) = a\cos(bt) + c$, where $a, b, c \in \mathbb{R}$.

Find the values of a, b and c.

Markscheme

amplitude is $\frac{110}{2} = 55$ ***(A1)***

$a = -55$ ***A1***

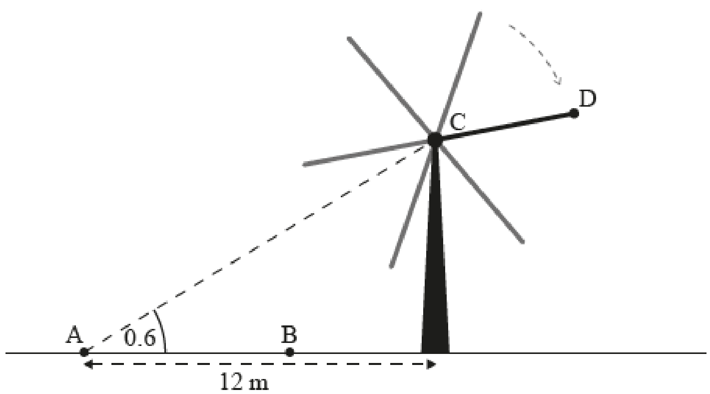
$c = 65$ ***A1***

$\frac{2\pi}{b} = 20$ OR $-55\cos(20b)+65 = 10$ ***(M1)***

$b = \frac{\pi}{10}(= 0.314)$ ***A1***

[5 marks]

The six blades of a windmill rotate around a centre point C. Points A and B and the base of the windmill are on level ground, as shown in the following diagram.



From point A the angle of elevation of point C is 0.6 radians.

12a. Given that point A is 12 metres from the base of the windmill, find the height of point C above the ground. *[2 marks]*

Markscheme

$\tan 0.6 = \frac{h}{12}$ ***(M1)***

$8.20964\ldots$

$8.21\,(\mathrm{m})$ ***A1***

[2 marks]

An observer walks 7 metres from point A to point B.

12b. Find the angle of elevation of point C from point B. *[2 marks]*

Markscheme

$\tan B = \frac{8.2096...}{5}$ OR $\tan^{-1} 1.6419...$ ***(A1)***

$1.02375...$

1.02 (radians) (accept 58.7°) ***A1***

[2 marks]

The observer keeps walking until he is standing directly under point C. The observer has a height of 1.8 metres, and as the blades of the windmill rotate, the end of each blade passes 2.5 metres over his head.

12c. Find the length of each blade of the windmill. *[2 marks]*

Markscheme

$x + 1.8 + 2.5 = 8.20964...$ (or equivalent) ***(A1)***

$3.90964...$

3.91 (m) ***A1***

[2 marks]

One of the blades is painted a different colour than the others. The end of this blade is labelled point D. The height h, in metres, of point D above the ground can be modelled by the function $h(t) = p\cos\left(\frac{3\pi}{10}t\right) + q$, where t is in seconds and $p,\ q \in \mathbb{R}$. When $t = 0$, point D is at its maximum height.

12d. Find the value of p and the value of q. *[4 marks]*

Markscheme

METHOD 1

recognition that blade length = amplitude, $p = \frac{\max - \min}{2}$ ***(M1)***

$p = 3.91$ ***A1***

centre of windmill = vertical shift, $q = \frac{\max + \min}{2}$ ***(M1)***

$q = 8.21$ ***A1***

METHOD 2

attempting to form two equations in terms of p and q ***(M1)(M1)***

$12.1192\ldots = p\cos\left(\frac{3\pi}{10} \cdot 0\right) + q, 4.3000\ldots = p\cos\left(\frac{3\pi}{10} \cdot \frac{10}{3}\right) + q$

$p = 3.91$ ***A1***

$q = 8.21$ ***A1***

[4 marks]

12e. If the observer stands directly under point C for one minute, point D will pass over his head n times. *[3 marks]*

Find the value of n.

Markscheme

appropriate working towards finding the period ***(M1)***

$\text{period} = \frac{2\pi}{\frac{3\pi}{10}} (= 6.6666\ldots)$

rotations per minute $= \frac{60}{\text{their period}}$ ***(M1)***

$n = 9$ (must be an integer) (accept $n = 10$, $n = 18$, $n = 19$) ***A1***

[3 marks]

13. Let $f(x) = 4\cos\left(\frac{x}{2}\right) + 1$, for $0 \leqslant x \leqslant 6\pi$. Find the values of x for which $f(x) > 2\sqrt{2} + 1$. *[8 marks]*

Markscheme

METHOD 1 – FINDING INTERVALS FOR *x*

$4\cos\left(\frac{x}{2}\right)+1>2\sqrt{2}+1$

correct working ***(A1)***

eg $4\cos\left(\frac{x}{2}\right)=2\sqrt{2},\ \cos\left(\frac{x}{2}\right)>\frac{\sqrt{2}}{2}$

recognizing $\cos^{-1}\frac{\sqrt{2}}{2}=\frac{\pi}{4}$ ***(A1)***

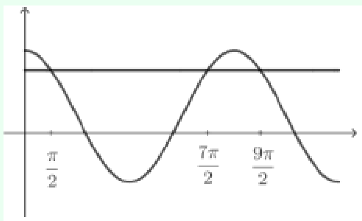
one additional correct value for $\frac{x}{2}$ (ignoring domain and equation/inequalities) ***(A1)***

eg $-\frac{\pi}{4},\ \frac{7\pi}{4},\ 315^{\circ},\ \frac{9\pi}{4},\ -45^{\circ},\ \frac{15\pi}{4}$

three correct values for x ***A1A1***

eg $\frac{\pi}{2},\ \frac{7\pi}{2},\ \frac{9\pi}{2}$

valid approach to find intervals ***(M1)***

eg 

correct intervals (must be in radians) ***A1A1*** ***N2***

$0\leqslant x<\frac{\pi}{2},\ \frac{7\pi}{2}<x<\frac{9\pi}{2}$

Note: If working shown, award ***A1A0*** if inclusion/exclusion of endpoints is incorrect. If no working shown award ***N1***.
If working shown, award ***A1A0*** if both correct intervals are given, **and** additional intervals are given. If no working shown award ***N1***.
Award ***A0A0*** if inclusion/exclusion of endpoints are incorrect **and** additional intervals are given.

METHOD 2 – FINDING INTERVALS FOR $\frac{x}{2}$

$4\cos\left(\frac{x}{2}\right)+1>2\sqrt{2}+1$

correct working ***(A1)***

eg $4\cos\left(\frac{x}{2}\right)=2\sqrt{2},\ \cos\left(\frac{x}{2}\right)>\frac{\sqrt{2}}{2}$

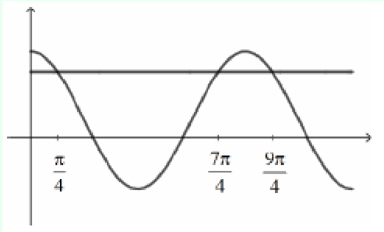
recognizing $\cos^{-1}\frac{\sqrt{2}}{2}=\frac{\pi}{4}$ ***(A1)***

one additional correct value for $\frac{x}{2}$ (ignoring domain and equation/inequalities) ***(A1)***

eg $-\frac{\pi}{4},\ \frac{7\pi}{4},\ 315^{\circ},\ \frac{9\pi}{4},\ -45^{\circ},\ \frac{15\pi}{4}$

three correct values for $\frac{x}{2}$ ***A1*** *eg* $\frac{\pi}{4}, \frac{7\pi}{4}, \frac{9\pi}{4}$

valid approach to find intervals ***(M1)***

eg 

one correct interval for $\frac{x}{2}$ ***A1***

eg $0 \leqslant \frac{x}{2} < \frac{\pi}{4}, \frac{7\pi}{4} < \frac{x}{2} < \frac{9\pi}{4}$

correct intervals (must be in radians) ***A1A1*** ***N2***

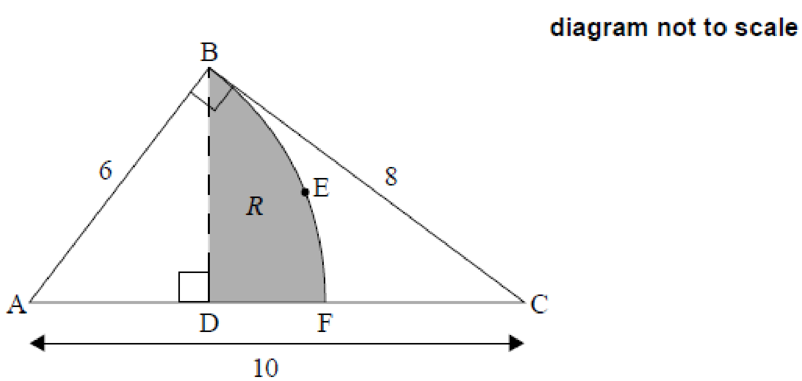
$0 \leqslant x < \frac{\pi}{2}, \ \frac{7\pi}{2} < x < \frac{9\pi}{2}$

Note: If working shown, award ***A1A0*** if inclusion/exclusion of endpoints is incorrect. If no working shown award ***N1***.
If working shown, award ***A1A0*** if both correct intervals are given, **and** additional intervals are given. If no working shown award ***N1***.
Award ***A0A0*** if inclusion/exclusion of endpoints are incorrect **and** additional intervals are given.

[8 marks]

The following diagram shows a right-angled triangle, ABC, with $\mathrm{AC} = 10\,\mathrm{cm}$, $\mathrm{AB} = 6\,\mathrm{cm}$ and $\mathrm{BC} = 8\,\mathrm{cm}$.

The points D and F lie on $[\mathrm{AC}]$.
$[\mathrm{BD}]$ is perpendicular to $[\mathrm{AC}]$.
BEF is the arc of a circle, centred at A.
The region R is bounded by $[\mathrm{BD}]$, $[\mathrm{DF}]$ and arc BEF.



14a. Find $\mathrm{B\hat{A}C}$. *[2 marks]*

Markscheme

correct working ***(A1)***

eg $\sin\alpha = \frac{8}{10}$, $\cos\theta = \frac{6}{10}$, $\cos \mathrm{B\hat{A}C} = \frac{6^2+10^2-8^2}{2\times6\times10}$

0.927295

$\mathrm{B\hat{A}C} = 0.927\ (= 53.1^\circ)$ ***(A1) N2***

[2 marks]

14b. Find the area of R. *[5 marks]*

Markscheme

Note: There may be slight differences in the final answer, depending on the approach the candidate uses in part (b). Accept a final answer that is consistent with their working.

correct area of sector ABF (seen anywhere) ***(A1)***

eg $\frac{1}{2}\times 6^2 \times 0.927$, $\frac{53.1301^\circ}{360^\circ}\times\pi\times 6^2$, 16.6913

correct expression (or value) for either $[\mathrm{AD}]$ or $[\mathrm{BD}]$ (seen anywhere) ***(A1)***

eg $\mathrm{AD} = 6\cos\left(\mathrm{B\hat{A}C}\right)\ (= 3.6)$

$\mathrm{BD} = 6\sin(53.1^\circ)\ (= 4.8)$

correct area of triangle ABD (seen anywhere) ***(A1)***

eg $\frac{1}{2}\times 6\cos\mathrm{B\hat{A}D}\times 6\sin\mathrm{B\hat{A}D}$, $9\sin\left(2\,\mathrm{B\hat{A}C}\right)$, 8.64 (exact)

appropriate approach (seen anywhere) ***(M1)***

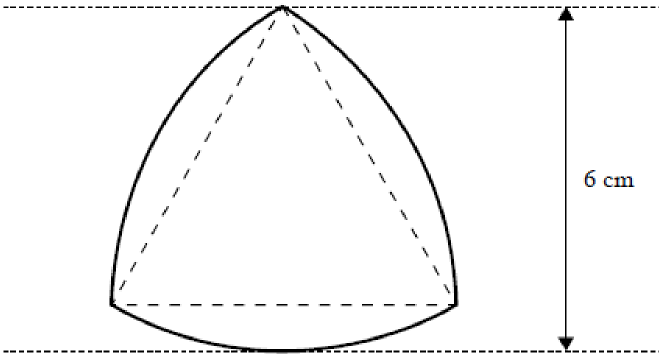
eg $\mathrm{A}_{\text{triangle ABD}} - \mathrm{A}_{\text{sector}}$, their sector − their triangle ABD

8.05131

area of shaded region $= 8.05$ (cm^2) ***A1 N2***

[5 marks]

The following shape consists of three arcs of a circle, each with centre at the opposite vertex of an equilateral triangle as shown in the diagram.



For this shape, calculate

15a. the perimeter. *[2 marks]*

Markscheme

each arc has length $r\theta = 6 \times \frac{\pi}{3} = 2\pi \ (= 6.283\ldots)$ ***(M1)***

perimeter is therefore $6\pi \ (= 18.8)$ (cm) ***A1***

[2 marks]

15b. the area. *[5 marks]*

Markscheme

area of sector, s, is $\frac{1}{2}r^2\theta = 18 \times \frac{\pi}{3} = 6\pi \ (= 18.84\ldots)$ ***(A1)***

area of triangle, t, is $\frac{1}{2} \times 6 \times 3\sqrt{3} = 9\sqrt{3} \ (= 15.58\ldots)$ ***(M1)(A1)***

Note: area of segment, k, is 3.261… implies area of triangle

finding $3s - 2t$ or $3k + t$ or similar

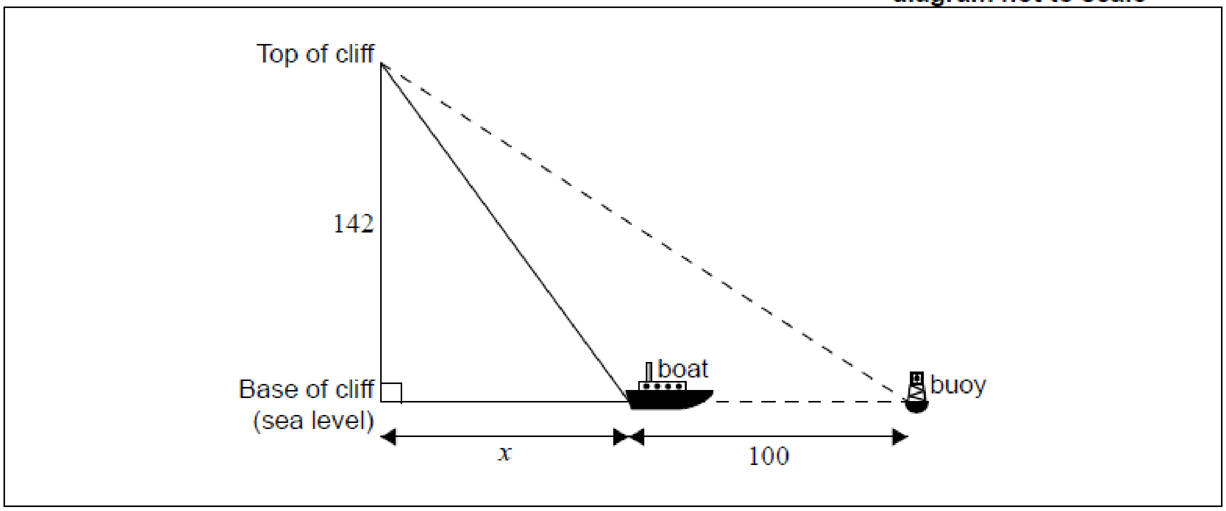
area $= 3s - 2t = 18\pi - 18\sqrt{3} \ (= 25.4)$ (cm^2) ***(M1)A1***

[5 marks]

A buoy is floating in the sea and can be seen from the top of a vertical cliff. A boat is travelling from the base of the cliff directly towards the buoy.

The top of the cliff is 142 m above sea level. Currently the boat is 100 metres from the buoy and the angle of depression from the top of the cliff to the boat is 64°.

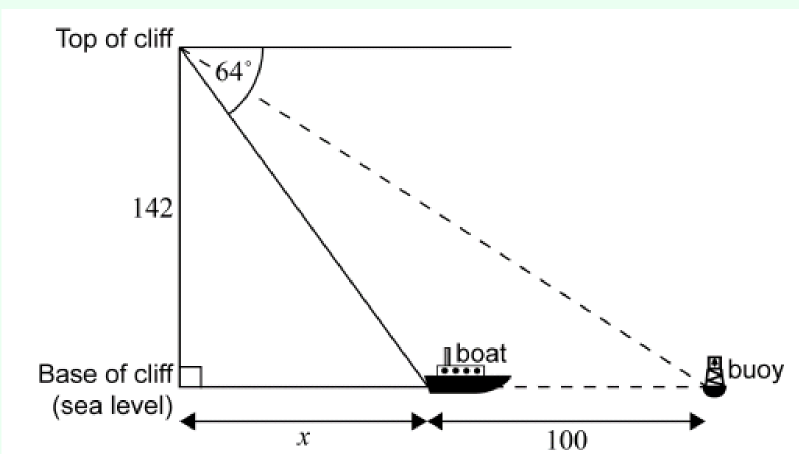
diagram not to scale



16. Draw and label the angle of depression on the diagram. *[1 mark]*

Markscheme

* This question is from an exam for a previous syllabus, and may contain minor differences in marking or structure.



(A1) (C1)

Note: The horizontal line must be shown and the angle of depression must be labelled. Accept a numerical or descriptive label.

[1 mark]

The lengths of two of the sides in a triangle are 4 cm and 5 cm. Let θ be the angle between the two given sides. The triangle has an area of $\frac{5\sqrt{15}}{2}$ cm^2.

17a. Show that $\sin\theta = \frac{\sqrt{15}}{4}$. *[1 mark]*

Markscheme

* This question is from an exam for a previous syllabus, and may contain minor differences in marking or structure.

EITHER

$\frac{5\sqrt{15}}{2} = \frac{1}{2} \times 4 \times 5\sin\theta$ ***A1***

OR

height of triangle is $\frac{5\sqrt{15}}{4}$ if using 4 as the base or $\sqrt{15}$ if using 5 as the base ***A1***

THEN

$\sin\theta = \frac{\sqrt{15}}{4}$ ***AG***

[1 mark]

17b. Find the two possible values for the length of the third side. *[6 marks]*

Markscheme

let the third side be x

$x^2 = 4^2 + 5^2 - 2 \times 4 \times 5 \times \cos\theta$ ***M1***

valid attempt to find $\cos\theta$ ***(M1)***

Note: Do not accept writing $\cos\left(\arcsin\left(\frac{\sqrt{15}}{4}\right)\right)$ as a valid method.

$\cos\theta = \pm\sqrt{1 - \frac{15}{16}}$

$= \frac{1}{4},\ -\frac{1}{4}$ ***A1A1***

$x^2 = 16 + 25 - 2 \times 4 \times 5 \times \pm\frac{1}{4}$

$x = \sqrt{31}$ or $\sqrt{51}$ ***A1A1***

[6 marks]

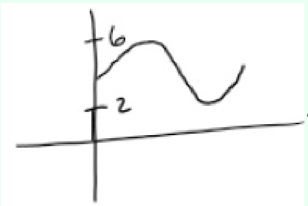
Let $f(x) = 2\sin(3x) + 4$ for $x \in \mathbb{R}$.

18a. The range of f is $k \le f(x) \le m$. Find k and m. *[3 marks]*

Markscheme

* This question is from an exam for a previous syllabus, and may contain minor differences in marking or structure.

valid attempt to find range ***(M1)***

eg 

, max = 6 min = 2,

$2\sin\left(3 \times \frac{\pi}{6}\right) + 4$ and $2\sin\left(3 \times \frac{\pi}{2}\right) + 4$, $2(1) + 4$ and $2(-1) + 4$,

$k = 2,\ m = 6$ ***A1A1 N3***

[3 marks]

Let $g(x) = 5f(2x)$.

18b. Find the range of g. *[2 marks]*

Markscheme

$10 \le y \le 30$ ***A2 N2***

[2 marks]

The function g can be written in the form $g(x) = 10\sin(bx) + c$.

18c. Find the value of b and of c. *[3 marks]*

Markscheme

evidence of substitution (may be seen in part (b)) ***(M1)***

eg $5\left(2\sin\left(3\left(2x\right)\right)+4\right)$, $3\left(2x\right)$

$b=6,\ c=20$ (accept $10\sin\left(6x\right)+20$) ***A1A1 N3***

Note: If no working shown, award ***N2*** for one correct value.

[3 marks]

18d. Find the period of g. *[2 marks]*

Markscheme

correct working ***(A1)***

eg $\frac{2\pi}{b}$

1.04719

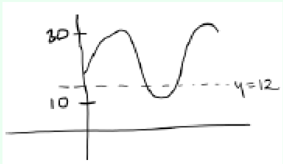
$\frac{2\pi}{6}$ $\left(=\frac{\pi}{3}\right)$, 1.05 ***A1 N2***

[2 marks]

18e. The equation $g\left(x\right)=12$ has two solutions where $\pi \le x \le \frac{4\pi}{3}$. Find both solutions. *[3 marks]*

Markscheme

valid approach *(M1)*

eg ,

$\sin^{-1}\left(-\frac{8}{10}\right)$, $6x = -0.927,\ -0.154549,\ x = 0.678147$

Note: Award ***M1*** for any correct value for x or $6x$ which lies outside the domain of f.

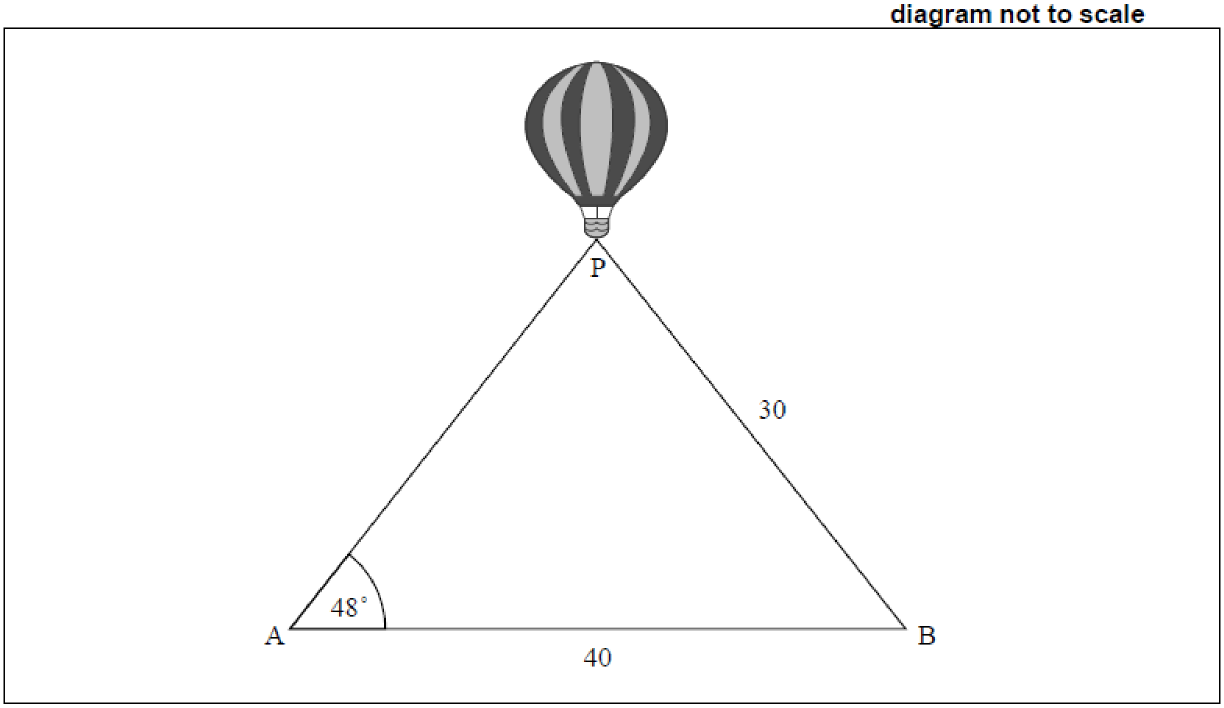
3.81974, 4.03424

$x = 3.82,\ x = 4.03$ (do not accept answers in degrees) ***A1A1 N3***

[3 marks]

Two fixed points, A and B, are 40 m apart on horizontal ground. Two straight ropes, AP and BP, are attached to the same point, P, on the base of a hot air balloon which is vertically above the line AB. The length of BP is 30 m and angle BAP is 48°.

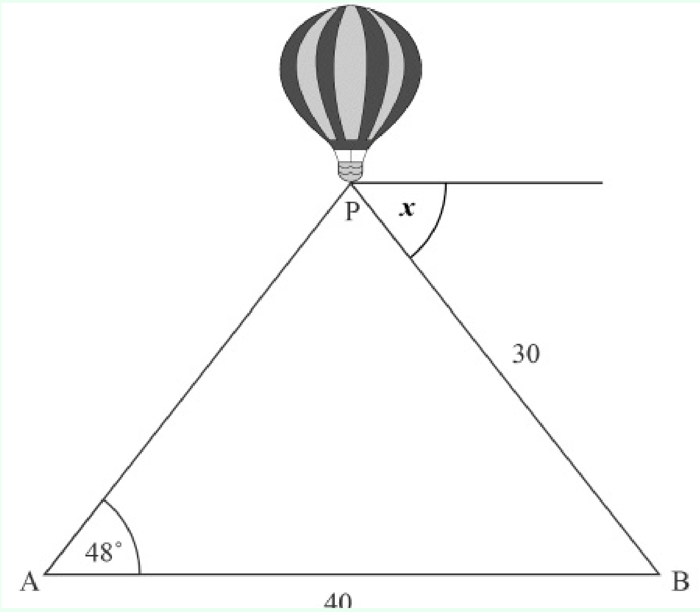
diagram not to scale



19a. On the diagram, draw and label with an *x* the angle of depression of B from P. *[1 mark]*

Markscheme

* This question is from an exam for a previous syllabus, and may contain minor differences in marking or structure.



(A1) (C1)

[1 mark]

Angle APB is acute.

19b. Find the size of angle APB. *[3 marks]*

Markscheme

$\frac{40}{\sin \text{APB}} = \frac{30}{\sin 48^\circ}$ ***(M1)(A1)***

Note: Award ***(M1)*** for substitution into sine rule, ***(A1)*** for correct substitution.

(angle APB =) 82.2° (82.2473...°) ***(A1) (C3)***

[3 marks]

19c. Find the size of the angle of depression of B from P. *[2 marks]*

Markscheme

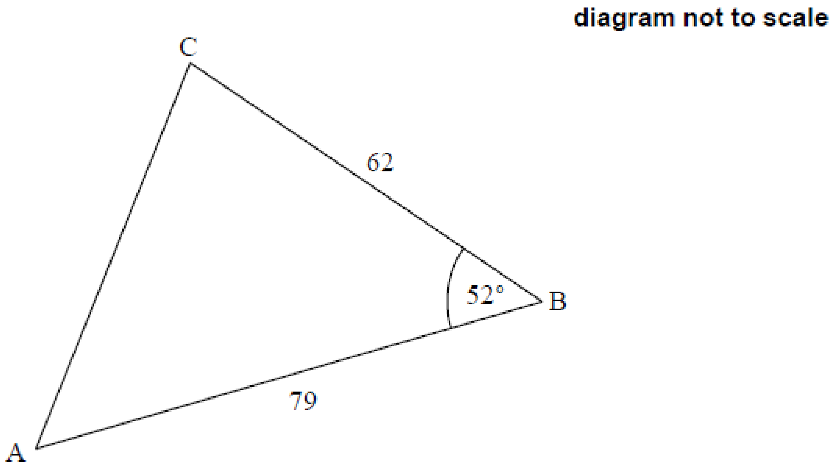
$180 - 48 - 82.2473...$ ***(M1)***

$49.8°$ $(49.7526...°)$ ***(A1)*****(ft)** ***(C2)***

Note: Follow through from parts (a) and (b).

[2 marks]

A park in the form of a triangle, ABC, is shown in the following diagram. AB is 79 km and BC is 62 km. Angle $A\hat{B}C$ is 52°.



20a. Calculate the length of side AC in km. *[3 marks]*

Markscheme

* This question is from an exam for a previous syllabus, and may contain minor differences in marking or structure.

$(AC^2 =)\ 62^2 + 79^2 - 2 \times 62 \times 79 \times \cos(52°)$ ***(M1)(A1)***

Note: Award ***(M1)*** for substituting in the cosine rule formula, ***(A1)*** for correct substitution.

63.7 $(63.6708...)$ (km) ***(A1) (C3)***

[3 marks]

20b. Calculate the area of the park. *[3 marks]*

Markscheme

$\frac{1}{2} \times 62 \times 79 \times \sin(52°)$ ***(M1)(A1)***

Note: Award ***(M1)*** for substituting in the area of triangle formula, ***(A1)*** for correct substitution.

$1930\ \text{km}^2$ $(1929.83\ldots\text{km}^2)$ ***(A1) (C3)***

[3 marks]

21. Triangle ABC has $a = 8.1$ cm, $b = 12.3$ cm and area 15 cm^2. Find the largest possible perimeter of triangle ABC. *[7 marks]*

Markscheme

* This question is from an exam for a previous syllabus, and may contain minor differences in marking or structure.

correct substitution into the formula for area of a triangle ***(A1)***

eg $15 = \frac{1}{2} \times 8.1 \times 12.3 \times \sin C$

correct working for angle C ***(A1)***

eg $\sin C = 0.301114$, $17.5245\ldots$, 0.305860

recognizing that obtuse angle needed ***(M1)***

eg 162.475, 2.83573, $\cos C < 0$

evidence of choosing the cosine rule ***(M1)***

eg $a^2 = b^2 + c^2 - 2bc\cos(A)$

correct substitution into cosine rule to find c ***(A1)***

eg $c^2 = (8.1)^2 + (12.3)^2 - 2(8.1)(12.3)\cos C$

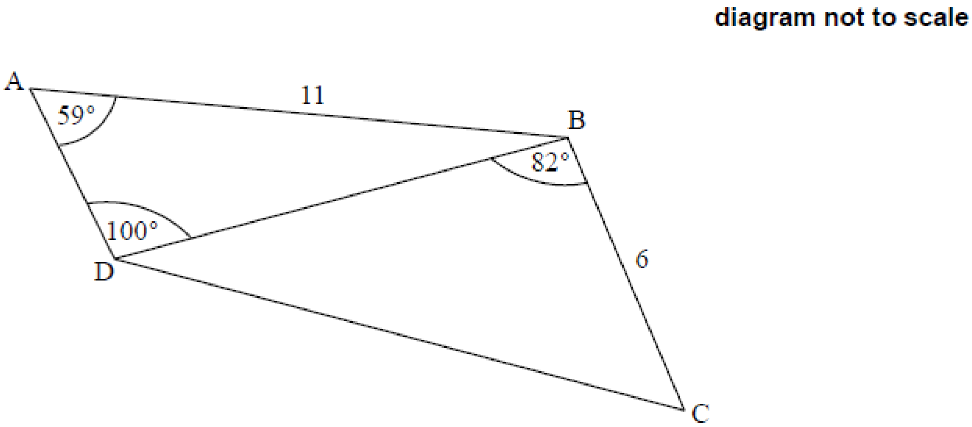
$c = 20.1720$ ***(A1)***

$8.1 + 12.3 + 20.1720 = 40.5720$

perimeter $= 40.6$ ***A1 N4***

[7 marks]

The following diagram shows quadrilateral ABCD.



$\mathrm{AB} = 11\,\mathrm{cm}$, $\mathrm{BC} = 6\,\mathrm{cm}$, $\mathrm{B}\hat{\mathrm{A}}\mathrm{D} = 100^\circ$, and $\mathrm{C}\hat{\mathrm{B}}\mathrm{D} = 82^\circ$

22a. Find DB. *[3 marks]*

Markscheme

* This question is from an exam for a previous syllabus, and may contain minor differences in marking or structure.

evidence of choosing sine rule ***(M1)***

eg $\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$

correct substitution ***(A1)***

eg $\frac{\mathrm{DB}}{\sin 59^\circ} = \frac{11}{\sin 100^\circ}$

9.57429

DB = 9.57 (cm) ***A1 N2***

[3 marks]

22b. Find DC. *[3 marks]*

Markscheme

evidence of choosing cosine rule ***(M1)***

eg

$a^2 = b^2 + c^2 - 2bc \cos\ (A),\ \mathrm{DC}^2 =\ \mathrm{DB}^2 +\ \mathrm{BC}^2\ -\ 2\mathrm{DB} \times\ \mathrm{BC} \times\ \cos\left(\mathrm{D}\hat{\mathrm{B}}\mathrm{C}\right.$

correct substitution into RHS ***(A1)***

eg $9.57^2 + 6^2 - 2 \times 9.57 \times 6 \times\ \cos 82°,\ \ 111.677$

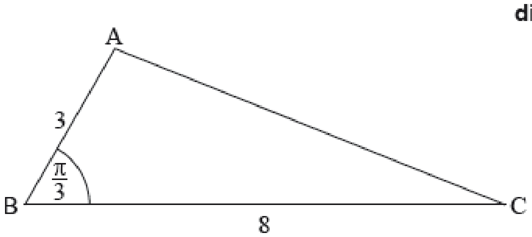
10.5677

DC = 10.6 (cm) ***A1 N2***

[3 marks]

The following diagram shows triangle ABC, with $\mathrm{AB} = 3\mathrm{cm}$, $\mathrm{BC} = 8\mathrm{cm}$, and $\mathrm{A\hat{B}C} = \frac{\pi}{3}$.

diagram not to scale



23a. Show that $\mathrm{AC} = 7\ \mathrm{cm}$. *[4 marks]*

Markscheme

* This question is from an exam for a previous syllabus, and may contain minor differences in marking or structure.

evidence of choosing the cosine rule ***(M1)***

$eg c^2 = a^2 + b^2 - ab\cos C$

correct substitution into RHS of cosine rule ***(A1)***

$eg 3^2 + 8^2 - 2 \times 3 \times 8 \times \cos\frac{\pi}{3}$

evidence of correct value for $\cos\frac{\pi}{3}$ (may be seen anywhere, including in cosine rule) ***A1***

$eg \cos\frac{\pi}{3} = \frac{1}{2},\ \mathrm{AC}^2 = 9 + 64 - \left(48 \times \frac{1}{2}\right),\ 9 + 64 - 24$

correct working clearly leading to answer ***A1***

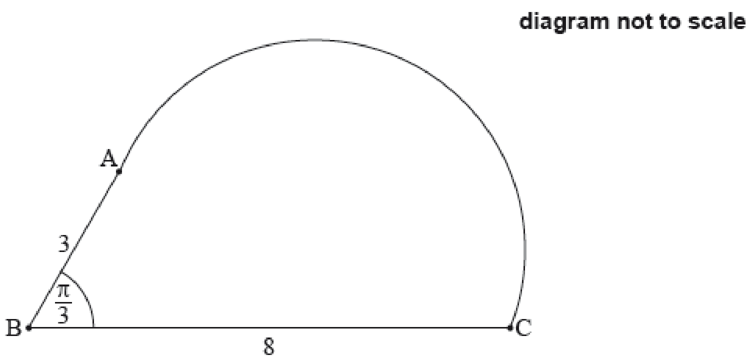
e$g \mathrm{AC}^2 = 49,\ b = \sqrt{49}$

$\mathrm{AC} = 7\ (\mathrm{cm})$ ***AG*** ***N0***

Note: Award no marks if the only working seen is $\mathrm{AC}^2 = 49$ or $\mathrm{AC} = \sqrt{49}$ (or similar).

[4 marks]

23b. The shape in the following diagram is formed by adding a semicircle with diameter [AC] to the triangle. *[3 marks]*



Find the exact perimeter of this shape.

Markscheme

correct substitution for semicircle ***(A1)***

eg $\text{semicircle} = \frac{1}{2}(2\pi \times 3.5),\ \frac{1}{2} \times \pi \times 7,\ 3.5\pi$

valid approach (seen anywhere) ***(M1)***

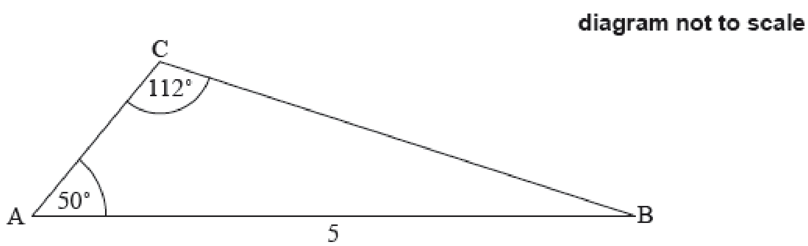
eg

$\text{perimeter} = \text{AB} + \text{BC} + \text{semicircle}, 3 + 8 + \left(\frac{1}{2} \times 2 \times \pi \times \frac{7}{2}\right),\ 8 + 3 + 3.5\pi$

$11 + \frac{7}{2}\pi\ (= 3.5\pi + 11)\ (\text{cm})$ ***A1*** ***N2***

[3 marks]

The following diagram shows a triangle ABC.



$\text{AB} = 5\text{cm}, \text{C}\hat{\text{A}}\text{B} = 50°$ and $\text{A}\hat{\text{C}}\text{B} = 112°$

24a. Find BC. *[3 marks]*

Markscheme

* This question is from an exam for a previous syllabus, and may contain minor differences in marking or structure.

evidence of choosing sine rule ***(M1)***

eg $\frac{\sin A}{a} = \frac{\sin B}{b}$

correct substitution ***(A1)***

eg $\frac{\text{BC}}{\sin 50} = \frac{5}{\sin 112}$

4.13102

$\text{BC} = 4.13\ (\text{cm})$ ***A1*** ***N2***

[3 marks]

24b. Find the area of triangle ABC. *[3 marks]*

Markscheme

correct working ***(A1)***

eg $\hat{\mathrm{B}} = 180 - 50 - 112$, 18°, $\mathrm{AC} = 1.66642$

correct substitution into area formula ***(A1)***

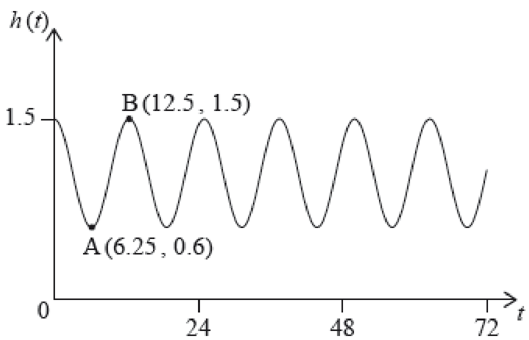
eg $\frac{1}{2} \times 5 \times 4.13 \times \sin 18,\ 0.5(5)(1.66642)\sin 50,\ \frac{1}{2}(4.13)(1.66642)\sin 112$

3.19139

$\text{area} = 3.19\ (\text{cm}^2)$ ***A1*** ***N2***

[3 marks]

At Grande Anse Beach the height of the water in metres is modelled by the function $h(t) = p\cos(q \times t) + r$, where t is the number of hours after 21:00 hours on 10 December 2017. The following diagram shows the graph of h , for $0 \leqslant t \leqslant 72$.



The point $\mathrm{A}(6.25, 0.6)$ represents the first low tide and $\mathrm{B}(12.5, 1.5)$ represents the next high tide.

25a. How much time is there between the first low tide and the next high tide? *[2 marks]*

Markscheme

attempt to find the difference of x-values of A and B ***(M1)***

eg $6.25 - 12.5$

6.25 (hours), (6 hours 15 minutes) ***A1*** ***N2***

[2 marks]

25b. Find the difference in height between low tide and high tide. *[2 marks]*

Markscheme

attempt to find the difference of y-values of A and B ***(M1)***

eg $1.5 - 0.6$

$0.9\ (\mathrm{m})$ ***A1*** ***N2***

[2 marks]

25c. Find the value of p; *[2 marks]*

Markscheme

valid approach ***(M1)***

eg $\frac{\max - \min}{2},\ 0.9 \div 2$

$p = 0.45$ ***A1*** ***N2***

[2 marks]

25d. Find the value of q; *[3 marks]*

Markscheme

METHOD 1

period $= 12.5$ (seen anywhere) ***(A1)***

valid approach (seen anywhere) ***(M1)***

eg $\text{period} = \frac{2\pi}{b},\ q = \frac{2\pi}{\text{period}},\ \frac{2\pi}{12.5}$

0.502654

$q = \frac{4\pi}{25},\ 0.503\ \left(\text{or } -\frac{4\pi}{25},\ -0.503\right)$ ***A1 N2***

METHOD 2

attempt to use a coordinate to make an equation ***(M1)***

eg $p\cos(6.25q) + r = 0.6,\ p\cos(12.5q) + r = 1.5$

correct substitution ***(A1)***

eg $0.45\cos(6.25q) + 1.05 = 0.6,\ 0.45\cos(12.5q) + 1.05 = 1.5$

0.502654

$q = \frac{4\pi}{25},\ 0.503\ \left(\text{or } -\frac{4\pi}{25},\ -0.503\right)$ ***A1 N2***

[3 marks]

25e. Find the value of r. *[2 marks]*

Markscheme

valid method to find r ***(M1)***

eg $\frac{\max + \min}{2},\ 0.6 + 0.45$

$r = 1.05$ ***A1 N2***

[2 marks]

25f. There are two high tides on 12 December 2017. At what time does the second high tide occur? *[3 marks]*

Markscheme

METHOD 1

attempt to find start or end t-values for 12 December ***(M1)***

eg $3+24,\ t=27,\ t=51$

finds t-value for second max ***(A1)***

$t=50$

23:00 (or 11 pm) ***A1*** ***N3***

METHOD 2

valid approach to list either the times of high tides after 21:00 or the t-values of high tides after 21:00, showing at least two times ***(M1)***

eg $21{:}00+12.5,\ 21{:}00+25,\ 12.5+12.5,\ 25+12.5$

correct time of first high tide on 12 December ***(A1)***

eg 10:30 (or 10:30 am)

time of second high tide = 23:00 ***A1*** ***N3***

METHOD 3

attempt to set **their** h equal to 1.5 ***(M1)***

eg $h(t)=1.5,\ 0.45\cos\left(\frac{4\pi}{25}t\right)+1.05=1.5$

correct working to find second max ***(A1)***

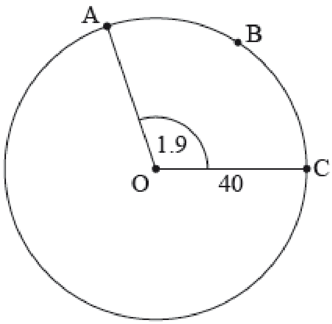
eg $0.503t=8\pi,\ t=50$

23:00 (or 11 pm) ***A1*** ***N3***

[3 marks]

The following diagram shows a circle with centre O and radius 40 cm.

diagram not to scale



The points A, B and C are on the circumference of the circle and $\mathrm{A\hat{O}C} = 1.9 \mathrm{radians}$.

26a. Find the length of arc ABC. *[2 marks]*

Markscheme

* This question is from an exam for a previous syllabus, and may contain minor differences in marking or structure.

correct substitution into arc length formula ***(A1)***

eg $(40)(1.9)$

$\text{arc length} = 76\ (\text{cm})$ ***A1 N2***

[2 marks]

26b. Find the perimeter of sector OABC. *[2 marks]*

Markscheme

valid approach ***(M1)***

eg $\text{arc} + 2r,\ 76 + 40 + 40$

$\text{perimeter} = 156\ (\text{cm})$ ***A1 N2***

[2 marks]

26c. Find the area of sector OABC. *[2 marks]*

Markscheme

correct substitution into area formula ***(A1)***

$eg\frac{1}{2}(1.9)(40)^2$

$\text{area} = 1520\ (\text{cm}^2)$ ***A1*** ***N2***

[2 marks]

The depth of water in a port is modelled by the function $d(t) = p\cos qt + 7.5$, for $0 \leqslant t \leqslant 12$, where t is the number of hours after high tide.

At high tide, the depth is 9.7 metres.

At low tide, which is 7 hours later, the depth is 5.3 metres.

27a. Find the value of p. *[2 marks]*

Markscheme

* This question is from an exam for a previous syllabus, and may contain minor differences in marking or structure.

valid approach ***(M1)***

$eg\frac{\text{max}-\text{min}}{2}$, sketch of graph, $9.7 = p\cos(0) + 7.5$

$p = 2.2$ ***A1*** ***N2***

[2 marks]

27b. Find the value of q. *[2 marks]*

Markscheme

valid approach ***(M1)***

$egB = \frac{2\pi}{\text{period}}$, period is $14,\ \frac{360}{14},\ 5.3 = 2.2\cos 7q + 7.5$

0.448798

$q = \frac{2\pi}{14}\ \left(\frac{\pi}{7}\right)$, (do not accept degrees) ***A1*** ***N2***

[2 marks]

27c. Use the model to find the depth of the water 10 hours after high tide. *[2 marks]*

Markscheme

valid approach ***(M1)***

$eg d(10),\ 2.2\cos\left(\frac{20\pi}{14}\right)+7.5$

7.01045

7.01 (m) ***A1*** ***N2***

[2 marks]