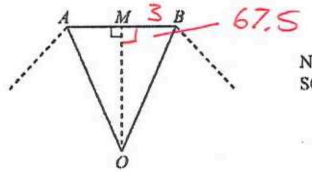
1 *ABCDEFGH* is a regular octagon with sides of length 6 cm.
The diagram shows part of the octagon.
O is the centre of the octagon and *M* is the midpoint of *AB*.



NOT TO SCALE

(a) (i) Show that angle *OAM* is 67.5°.

$\frac{(8-2)\times 180}{8} = 135$

$\frac{135}{2} = 67.5$

[2]

(ii) Calculate the area of the octagon.

$\tan 67.5 = \frac{MO}{3}$

$MO = 7.242640687$

$\text{Area} = 16 \times \left[\frac{1}{2}(3)(7.24\ldots)\right]$

$= 173.8233765$

173.8 cm² [4]

(b) Find the area of the circle that passes through the vertices of the octagon.

$\cos 67.5 = \frac{\cancel{6}\,3}{BO}$

$BO = \frac{3}{\cos 67.5}$

$= 7.8$

πr^2

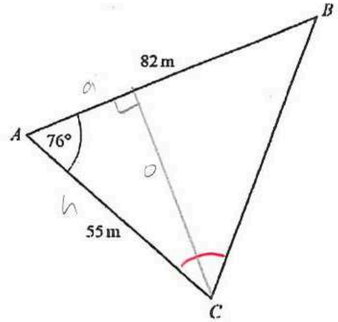
$= \pi(7.83\ldots)^2$

$= 193.069\ldots$ cm² [3]

$= 193$

[Total: 9]

2



NOT TO SCALE

$\sin 76° = \frac{o}{h}$

The diagram shows a field *ABC*.

(a) Calculate *BC*.

$BC^2 = 82^2 + 55^2 - 2(82)(55)\cos 76°$

$= 7566.864502\ldots$

$= 86.98772616$

BC = 87.0 m [3]

(b) Calculate angle *ACB*.

$\frac{\sin ACB}{82} = \frac{\sin 76°}{\cancel{76}\,87}$

Angle *ACB* = 66.1 [3]

(c) A gate, G, lies on AB at the shortest distance from C.

Calculate AG.

$AG = 55 \cancel{\sin}\overset{\cos}{} 76°$

$= 13.3057$

$AG =$ 13.3 m [3]

(d) A different triangular field PQR has the same area as ABC.
$PQ = 90$ m and $QR = 60$ m.

Work out the two possible values of angle PQR.

$\text{Area} = \frac{1}{2}(a)(b)\sin C$

$= \frac{1}{2}(55)(82)\sin 76$

$= 2188.016863$

$2188.016863 = \frac{1}{2}(90)(60)\sin PQR$

$\sin PQR = 0.8103766158$

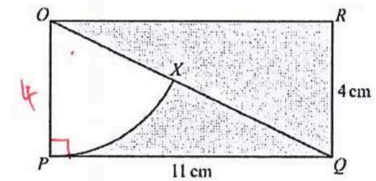
$= 54.13$

$\sin 54.1 = \sin(180 - 54.1)$

Angle $PQR =$ 54.1 or 125.9 [5]

[Total: 14]

3



NOT TO SCALE

$\tan\theta = \frac{11}{4}$

$\theta = \tan^{-1}\left(\frac{11}{4}\right)$

$= 70.0$

The diagram shows a rectangle $OPQR$ with length 11 cm and width 4 cm.
OQ is a diagonal and OPX is a sector of a circle, centre O.

Calculate the percentage of the rectangle that is shaded.

$\left(\frac{70}{360} \times \pi(4)^2\right)$

$= 9.77$

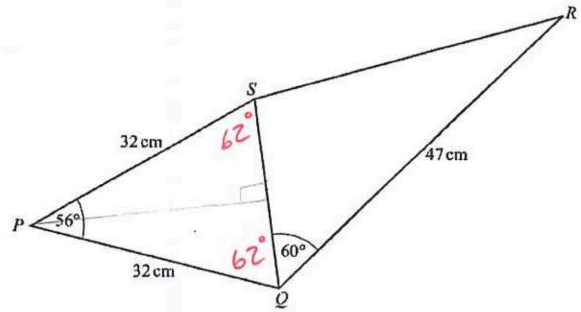
$\frac{9.77}{11 \times 4} = 0.222186422 4$

$1 - 0.2221864224$

77.78 % [5]

[Total: 5]

4



NOT TO SCALE

The diagram shows a quadrilateral $PQRS$ formed from two triangles, PQS and QRS.
Triangle PQS is isosceles, with $PQ = PS = 32$ cm and angle $SPQ = 56°$.
$QR = 47$ cm and angle $SQR = 60°$.

(a) Calculate SR.

$SQ^2 = 32^2 + 32^2 - 2(32)^2 \cos 56$

$SQ = 30.04618002$

$SR^2 = SQ^2 + 47^2 - 2(SQ)(47)\cos 60$

$SR = 41.22623525$

$SR =$ ......41.2...... cm [4]

(b) Calculate the shortest distance from P to SQ.

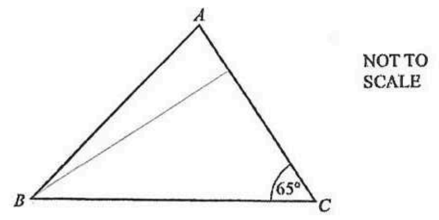
$32 \sin 62°$

$= 28.25432297$

......28.3...... cm [3]

[Total: 7]

5



The shortest distance from B to AC is 12.8 cm.

Calculate BC.

$\sin 65 = \frac{12.8}{BC}$

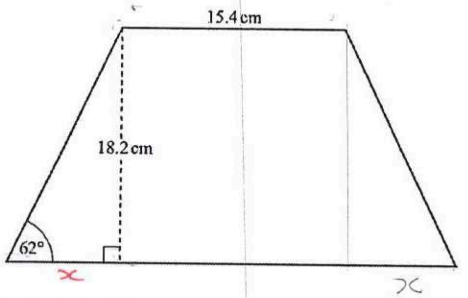
$BC = \frac{12.8}{\sin 65}$

$= 14.12323736$

$BC =$ ......14.1...... cm [3]

[Total: 3]

6



NOT TO SCALE

The diagram shows a trapezium.
The trapezium has one line of symmetry.

Work out the area of the trapezium.

$\tan 62^\circ = \frac{18.2}{x}$

$x = \frac{18.2}{\tan 62^\circ}$

$= 9.677111656$

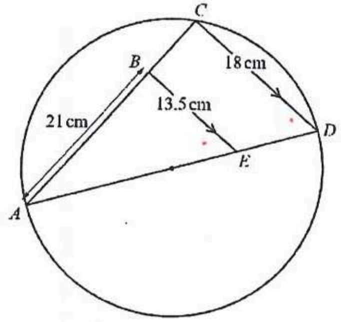
$\left(\frac{15.4 + 15.4 + 2x}{2}\right)(18.2)$

$= 456.403$

456 .... cm² [4]

[Total: 4]

7



NOT TO SCALE

C lies on a circle with diameter *AD*.
B lies on *AC* and *E* lies on *AD* such that *BE* is parallel to *CD*.
AB = 21 cm, *CD* = 18 cm and *BE* = 13.5 cm.

Work out the radius of the circle.

$\tan\theta = \frac{21}{13.5}$

$\theta = \tan^{-1}\left(\frac{21}{13.5}\right)$

$= 57.26477373$

$\frac{33.2866\ldots}{2}$

$= 16.64331698$

$\cos \cancel{\sin}\, 57.264 = \frac{18}{h}$

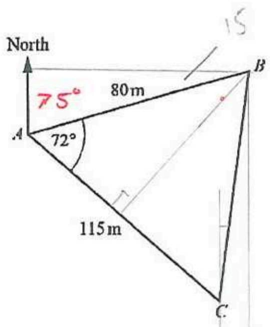
$h = \frac{18}{\cos 57.264\ldots}$

$= 33.28663395$

16.6 .... cm [5]

[Total: 5]

8



NOT TO SCALE

The diagram shows the positions of three points A, B and C in a field.

(a) Show that BC is 118.1 m, correct to 1 decimal place.

$BC = \sqrt{80^2 + 115^2 - 2(80)(115)\cos 72}$

$= 118.0639119$

$= 118.1 \quad (1dp)$

[3]

(b) Calculate angle ABC.

$\frac{\sin B}{115} = \frac{\sin 72^\circ}{118.1}$

$B = 67.87667041\ldots$

Angle ABC = ...67.9........ [3]

(c) The bearing of C from A is 147°.

Find the bearing of

(i) A from B,

$360 - 90 - 15 = 255$

........255........ [3]

(ii) B from C.

$90 - 15 - 67.9 = 7.1$

........7.1........ [2]

(d) Mitchell takes 35 seconds to run from A to C.

Calculate his average running speed in kilometres per hour.

$s = \frac{d}{t} = \frac{115\text{ m}}{35\text{ s}} = \frac{0.115\text{ km}}{35 \div 60 \div 60} = 11.828\ldots$

........11.8........ km/h [3]

(e) Calculate the shortest distance from point B to AC.

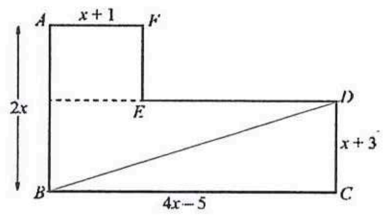
$80 \sin 72^\circ = 76.0845213$

........76.1........ m [3]

[Total: 17]

9 All the lengths in this question are in centimetres.

cm



NOT TO SCALE

The diagram shows a shape *ABCDEF* made from two rectangles.
The total area of the shape is 342 cm^2.

(a) Show that $x^2 + x - 72 = 0$.

$(x+1)(2x-(x+3)) + (4x-5)(x+3) = 342$

$(x+1)(x-3) + (4x-5)(x+3) = 342$

$x^2 - 2x - 3 + 4x^2 + 7x - 15 = 342$

$5x^2 + 5x - 18 - 342 = 0$

$5x^2 + 5x - 360 = 0$

$x^2 + x - 72 = 0$

[5]

(b) Solve by factorisation.
$x^2 + x - 72 = 0$

$(x+9)(x-8) = 0$

$x = -9$ or $x = 8$

$x =$ 8 or $x =$ −9 [3]

(c) Work out the perimeter of the shape *ABCDEF*.

$x+1 + 2x + 4x - 5 + x + 3 + [2x - (x+3)] + [4x - 5 - (x+1)]$

$x + 1 + 2x + 4x - 5 + x + 3 + x - 3 + 3x - 6$

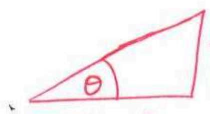
$9x - 4 + 3x - 6$

$9(8) - 4 + 3(8) - 6$

$= 86$

86 cm [2]

(d) Calculate angle *DBC*.



$x+3 = 8+3 = 11$

$4x-5$

$4(8)-5$

$= 27$

$\tan\theta = \frac{11}{27}$

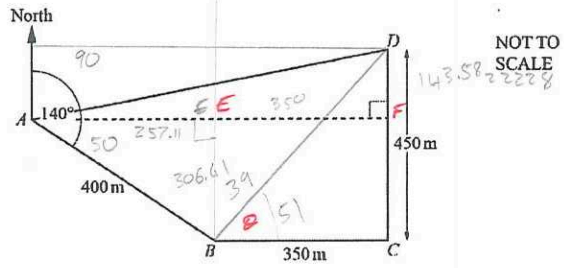
$\theta = \tan^{-1}\left(\frac{11}{27}\right)$

$= 22.1663...$

Angle *DBC* = 22.2 (3sf) [2]

[Total: 12]

10



The diagram shows a field $ABCD$.
The bearing of B from A is 140°.
C is due east of B and D is due north of C.
$AB = 400$ m, $BC = 350$ m and $CD = 450$ m.

(a) Find the bearing of D from B.

$\tan\theta = \frac{450}{350}$

$\theta = \tan^{-1}\left(\frac{450}{350}\right)$

$= 52.12501...$

$90 - 52.12501...$

$= 39.87498...$

039.9 .... [2]

(b) Calculate the distance from D to A.

$\cos 50 = \frac{AE}{400}$ $\quad \cos 50 = \frac{AE}{400}$

$AE = 400\cos 50$ $\quad AE = 400\cos 50$

$= 257.1150439$ $= 257.1150439...$

$\sin 50 = \frac{EB}{400}$ $\quad \sin 50 = \frac{EB}{400}$

$EB = 400\sin 50$ $\quad EB = 400\sin 50$

$= 306.4177772$ $= 306.4177772$

$AD^2 = 143.58222228^2 + 607.1150439$

$AD = \sqrt{143.58...^2 + 607.115...^2}$

$= 623.86259...$

$= 624$ (3sf)

$DF = DC - BE = 450 - 306.41...$

$= 143.58....$

$AF = BC + AE$

$= 350 + 257.11$

$= 607.115....$

624 .... m [6]

(c) Jono runs around the field from A to B, B to C, C to D and D to A.
He runs at a speed of 3 m/s.

Calculate the total time Jono takes to run around the field.
Give your answer in minutes and seconds, correct to the nearest second.

$400 + 350 + 450 + 624 = 1824\text{m}$

$S = \frac{D}{T}$ $\quad T = \frac{D}{S}$

$= \frac{1824\text{m}}{3\text{m/s}}$

$= 608$ sec.

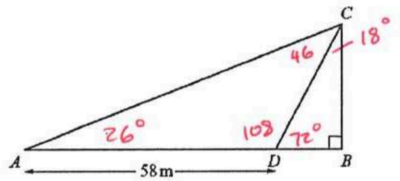
10 .... min .... 8 .... s [4]

[Total: 12]

$608 = 600 + 8$

$= 10\text{min} + 8\text{sec}.$

11



NOT TO
SCALE

In the diagram, BC is a vertical wall standing on horizontal ground AB.
D is the point on AB where $AD = 58$ m.
The angle of elevation of C from A is 26°.
The angle of elevation of C from D is 72°.

(a) Show that $AC = 76.7$ m, correct to 1 decimal place.

$$\frac{AC}{\sin 108°} = \frac{58}{\sin 46}$$

$$AC = \sin 108\left(\frac{58}{\sin 46}\right)$$

$$= 76.68220023$$

$$\approx 76.7 \quad (3sf)$$

[5]

(b) Calculate BD.

$$76.78220023 \cos 26 = AB$$

$$AB = 68.92240382$$

$$BD = AB - 58$$

$$= 10.92240382\ldots$$

BD = ...10.9.... m [3]

[Total: 8]