LEVEL 1

Unit Penalty applies in parts (a) and (d) and Financial Penalty applies in parts (b) and (e).

(a) $BD^2 = 190^2 + 120^2 - 2(190)(120)\cos 75°$ (M1)(A1)

Note: *Award (M1) for substituted cosine formula, (A1) for correct substitution.*

$= 197$ m (A1)(G2)

Note: *If radians are used award a maximum of (M1)(A1)(A0).*

(b) cost = 196.717… × 17 (M1)

= 3344 USD (A1)(ft)(G2)

Note: *Accept 3349 from 197.*

(c) $\frac{\sin(\text{ABD})}{70} = \frac{\sin(115°)}{196.7}$ (M1)(A1)

Note: *Award (M1) for substituted sine formula, (A1) for correct substitution.*

$= 18.81°\ldots$ (A1)(ft)
$= 18.8°$ (AG)

Notes: *Both the unrounded and rounded answers must be seen for the final (A1) to be awarded. Follow through from their (a). If 197 is used the unrounded answer is 18.78°…*

(d) angle BDA = 46.2° (A1)

Area = $\frac{70 \times (196.717\ldots) \times \sin(46.2°)}{2}$ (M1)(A1)

Note: *Award (M1) for substituted area formula, (A1) for correct substitution.*

Area of ABD = 4970 m^2 (A1)(ft)(G2)

Notes: *If 197 used answer is 4980.*

Notes: *Follow through from (a) only. Award (G2) if there is no working shown and 46.2° not seen. If 46.2° seen without subsequent working, award (A1)(G2).*

(e) 4969.38… × 120 (M1)

= 596 327 USD (A1)(ft)(G2)

Notes: *Follow through from their (d).*

(f) $300\,000\left(1+\frac{r}{100}\right)^{15} = 600\,000$ or equivalent (A1)(M1)(A1)

Notes: *Award (A1) for 600 000 seen or implied by alternative formula, (M1) for substituted CI formula, (A1) for correct substitutions.*

$r = 4.73$ (A1)(ft)(G3)

Notes: *Award G3 for 4.73 with no working. Award G2 for 4.7 with no working.*

[18]

2)

Unit penalty applies in parts (b) (c) and (d).

(a) Angle ABC = 50° (A1)

(b) $\frac{AC}{\sin 50°} = \frac{25}{\sin 55°}$ (M1)(A1)(ft)

Notes: *Award (M1) for substitution into the correct formula, (A1)(ft) for correct substitution. Follow through from their angle ABC.*

AC = 23.4 m (A1)(ft)(G2)

(c) Area of Δ ABC = $\frac{1}{2} \times 23.379\ldots \times 25 \times \sin 75°$ (M1)(A1)(ft)

Notes: *Award (M1) for substitution into the correct formula, (A1)(ft) for correct substitution.*
Follow through from their AC.

OR

Area of triangle ABC = $\frac{29.479\ldots \times 19.151\ldots}{2}$ (A1)(ft)(M1)

Note: *(A1)(ft) for correct values of AB (29.479...) and CN (19.151 ...).*
Follow through from their (a) and /or (b).
Award (M1) for substitution of their values of AB and CN into the correct formula.

Area of Δ ABC = 282 m^2 (A1)(ft)(G2)

Note: *Accept 283 m^2 if 23.4 is used.*

(d) NM = $\frac{25 \times \sin 50°}{2}$ (M1)(M1)

Note: *Award (M1) for 25 × sin 50° or equivalent for the length of CN, (M1) for dividing their CN by 2.*

NM = 9.58 m (A1)(ft)(G2)

Note: *Follow through from their angle ABC.*

Notes: *Premature rounding of CN leads to the answers 9.60 or 9.6.*
Award at most (M1)(M1)(A0) if working seen. Do not penalize with (AP).
CN may be found in (c).

Note: *The working for this part of the question may be in part (b).*

(e) Angle NCB = 40° seen (A1)(ft)

Note: Follow through from their (a).

From triangle MCP:

$MP^2 = (9.5756...)^2 + 12.5^2 - 2 \times 9.5756... \times 12.5 \times \cos(40°)$ (M1)(A1)(ft)

MP = 8.034... m (A1)(ft)(G3)

***Notes:** Award (M1) for substitution into the correct formula, (A1)(ft) for their correct substitution. Follow through from their (d).*

Award (G3) for correct value of MP seen without working.

OR

From right triangle MCP

CP = 12.5 m seen (A1)

$MP^2 = (12.5)^2 - (9.575\ldots)^2$ (M1)(A1)(ft)

MP = 8.034…m (A1)(G3)(ft)

***Notes:** Award (M1) for substitution into the correct formula, (A1)(ft) for their correct substitution. Follow through from their (d).*

*Award **(G3)** for correct value of MP seen without working.*

OR

From right triangle MCP

Angle MCP = 40° seen (A1)(ft)

$\frac{MP}{12.5} = \sin(40°)$ or equivalent (M1)(A1)(ft)

MP = 8.034... m (A1)(G3)(ft)

***Notes:** Award (M1) for substitution into the correct formula, (A1)(ft) for their correct substitution. Follow through from their (a).*

Award (G3) for correct value of MP seen without working.

The goat cannot reach point P as MP > 7 m. (A1)(ft)

***Note:** Award (A1)(ft) only if their value of MP is compared to 7 m, and conclusion is stated.*

[15]

3)

(a) (i) A(0, 4) *Accept* $x = 0, y = 4$ (A1)

(ii) B(8, 0) *Accept* $x = 8, y = 0$ (A1)(ft)

Note: *Award (A0) if coordinates are reversed in (i) and (A1)(ft) in (ii).*

(b) $AB = \sqrt{8^2 + 4^2} = \sqrt{80}$ (M1)

AB = 8.944 (A1)

= 8.94 (AG)

(c) (i) $y = -0.5x + 4$ (M1)

Gradient AB = –0.5 (A1)

Note: *Award (A2) if –0.5 seen.*

OR

Gradient AB = $\frac{(0-4)}{(8-0)}$ (M1)

$= -\frac{1}{2}$ (A1)

Note: *Award (M1) for correct substitution in the gradient formula. Follow through from their answers to part (a).*

Gradient CN = 2 (A1)(ft)(G2)

Note: *Special case: Follow through for gradient CN from their gradient AB.*

(ii) CN: $y = 2x + c$

$7 = 2(4) + c$ (M1)

Note: *Award (M1) for correct substitution in equation of a line.*

$y = 2x - 1$ (A1)(ft)(G2)

Note: *Accept alternative forms for the equation of a line including $y - 7 = 2(x - 4)$. Follow through from their gradient in (i).*

Note: *If $c = -1$ seen but final answer is not given, award (A1)(d).*

(d) $x + 2(2x - 1) = 8$ *or equivalent* (M1)

N(2, 3) ($x = 2, y = 3$) (A1)(A1)(ft)(G3)

Note: *Award (M1) for attempt to solve simultaneous equations or a sketch of the two lines with an indication of the point of intersection.*

(e) Cosine rule: $\cos(A\hat{C}B) = \dfrac{5^2 + 8.06^2 - 8.944^2}{2 \times 5 \times 8.06}$ (M1)(A1)

Note: *Award (M1) for use of cosine rule with numbers from the problem substituted, (A1) for correct substitution.*

$A\hat{C}B = 82.9°$ (A1)(G2)

Note: *If alternative right-angled trigonometry method used award (M1) for use of trig ratio in both triangles, (A1) for correct substitution of their values in each ratio, (A1) for answer.*

Note: *Accept 82.8° with use of 8.94.*

(f) Area ACB = $\dfrac{5 \times 8.06 \sin(82.9)}{2}$ (M1)(A1)(ft)

Note: *Award (M1) for substituted area formula, (A1) for correct substitution. Follow through from their angle in part (e).*

OR

Area ACB = $\dfrac{AB \times CN}{2} = \dfrac{8.94 \times \sqrt{(4-2)^2 + (7-3)^2}}{2}$ (M1)(M1)(ft)

Note: *Award (M1) substituted area formula with their values, (M1) for substituted distance formula. Follow through from coordinates of N.*

Area ACB = 20.0 (A1)(ft)(G2)

Note: *Accept 20*

[18]

4)

Unit penalty (UP) applies in parts (a), (c) and (e).

(a) $AB^2 = 10^2 + 8^2 - 2 \times 10 \times 8 \times \cos 150°$ (M1)(A1)

$AB = 17.4$ km (A1)(G2)

Note: *Award (M1) for substitution into correct formula, (A1) for correct substitution, (A1) for correct answer.*

(b) $\frac{8}{\sin C\hat{A}B} = \frac{17.4}{\sin 150°}$ (M1)(A1)

$C\hat{A}B = 13.3°$ (A1)(ft)(G2)

Notes: *Award (M1) for substitution into correct formula, (A1) for correct substitution, (A1) for correct answer. Follow through from their answer to part (a).*

(c) $AD = 8.70$ km (8.7 km) (A1)(ft)

Note: *Follow through from their answer to part (a).*

(d) $DT = \tan(13.29...°) \times 8.697... = 2.0550...$ (M1)(A1)
$= 2.06$ (AG)

Notes: *Award (M1) for correct substitution in the correct formula, award (A1) for the unrounded answer seen. If 2.06 not seen award at most (M1)(A0).*

(e) $\sqrt{8.70^2 + 2.06^2} + 8.70 + 2.06$ (A1)(M1)

$= 19.7$ km (A1)(ft)(G2)

Note: *Award (A1) for AT, (M1) for adding the three sides of the triangle ADT, (A1)(ft) for answer. Follow through from their answer to part (c).*

(f) $\frac{19.7}{70} \times 60 + 10$ (M1)(M1)

$= 26.9$ (A1)(ft)

Note: *Award (M1) for time on road in minutes, (M1) for adding 10, (A1)(ft) for unrounded answer. Follow through from their answer to (e).*

$= 27$ (nearest minute) (A1)(ft)(G3)

Note: *Award (A1)(ft) for their unrounded answer given to the nearest minute.*

[16]

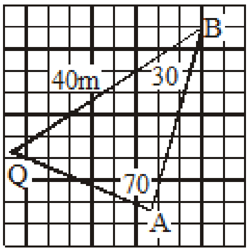
LEVEL 2

1)

(a) $\frac{PQ}{40} = \tan 36°$

$\Rightarrow PQ \approx 29.1$ m (3 sf) (A1) (C1)

(b)



$A\hat{Q}B = 80°$ (A1)

$\frac{AB}{\sin 80°} = \frac{40}{\sin 70°}$ (M1)

Note: *Award (M1) for correctly substituting.*

$\Rightarrow AB = 41\ 9.$ m (3 sf) (A1) (C3)

[4]

2)

(a) finding $A\hat{B}C = 110°$ (= 1.92 radians) (A1)

evidence of choosing cosine rule (M1)

e.g. $AC^2 = AB^2 + BC^2 - 2(AB)(BC)\cos A\hat{B}C$

correct substitution A1

e.g. $AC^2 = 25^2 + 40^2 - 2(25)(40)\cos 110°$

AC = 53.9 (km) A1 N3

(b) **METHOD 1**

correct substitution into the sine rule A1

e.g. $\frac{\sin B\hat{A}C}{40} = \frac{\sin 110°}{53.9}$

$B\hat{A}C = 44.2°$ A1

bearing = 074° A1 N1

METHOD 2

correct substitution into the cosine rule A1

e.g. $\cos B\hat{A}C = \frac{40^2 - 25^2 - 53.9^2}{-2(25)(53.9)}$

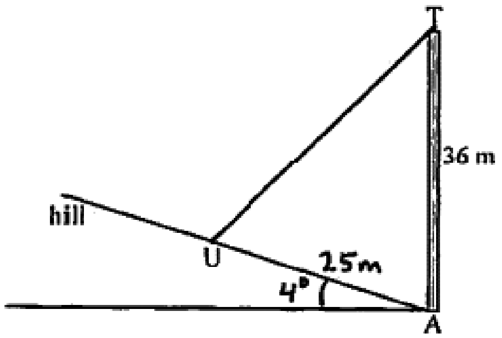
$B\hat{A}C = 44.3°$ A1

bearing = 074° A1 N1

[7]

3)

(a)



A1A1A1 N3 3

Note: *Award A1 for labelling 4° with horizontal, A1 for labelling [AU] 25 metres, A1 for drawing [TU].*

(b) $T\hat{A}U = 86°$ (A1)

evidence of choosing cosine rule (M1)

correct substitution A1

e.g. $x^2 = 25^2 + 36^2 - 2(25)(36)\cos 86°$

$x = 42.4$ A1 N3 4

[7]

4)

(a) Sine rule $\frac{PR}{\sin 35} = \frac{9}{\sin 120}$ (M1)(A1)

$PR = \frac{9\sin 35}{\sin 120}$

$= 5.96$ km (A1) 3

(b) **EITHER**

Sine rule to find PQ

$PQ = \frac{9\sin 25}{\sin 120}$ (M1)(A1)

$= 4.39$ km (A1)

OR

Cosine rule: $PQ^2 = 5.96^2 + 9^2 - (2)(5.96)(9)\cos 25$ (M1)(A1)

$= 19.29$

$PQ = 4.39$ km (A1)

Time for Tom $= \frac{4.39}{8}$ (A1)

Time for Alan $= \frac{5.96}{a}$ (A1)

Then $\frac{4.39}{8} = \frac{5.96}{a}$ (M1)

$a = 10.9$ (A1) 7

(c) $RS^2 = 4QS^2$ (A1)

$4QS^2 = QS^2 + 81 - 18 \times QS \times \cos 35$ (M1)(A1)

$3QS^2 + 14.74QS - 81 = 0$ (**or** $3x^2 + 14.74x - 81 = 0$) (A1)

$\Rightarrow$ QS = –8.20 **or** QS = 3.29 (G1)

therefore QS = 3.29 (A1)

OR

$$\frac{QS}{\sin S\hat{R}Q} = \frac{2QS}{\sin 35}$$ (M1)

$$\Rightarrow \sin S\hat{R}Q = \frac{1}{2}\sin 35$$ (A1)

$S\hat{R}Q = 16.7°$ (A1)

Therefore, $Q\hat{S}R = 180 - (35 + 16.7)$

$= 128.3°$ (A1)

$$\frac{9}{\sin 128.3} = \frac{QS}{\sin 16.7}\left(= \frac{SR}{\sin 35}\right)$$ (M1)

$$QS = \frac{9\sin 16.7}{\sin 128.3}\left(= \frac{9\sin 35}{2\sin 128.3}\right)$$

$= 3.29$ (A1) 6

[16]

5)

Note: Do not penalize missing units in this question.

(a) $AB^2 = 12^2 + 12^2 - 2 \times 12 \times 12 \times \cos 75°$ (A1)

$= 12^2(2 - 2\cos 75°)$ (A1)

$= 12^2 \times 2(1 \cos 75°)$

$AB = 12\sqrt{2(1 - \cos 75°)}$ (AG) 2

Note: The second (A1) is for transforming the initial expression to any simplified expression from which the given result can be clearly seen.

(b) $P\hat{O}B = 37.5°$ (A1)

$BP = 12 \tan 37.5°$ (M1)

$= 9.21$ cm (A1)

OR

$B\hat{P}A = 105°$ $B\hat{A}P = 37.5°$ (A1)

$\frac{AB}{\sin 105°} = \frac{BP}{\sin 37.5°}$ (M1)

$BP = \frac{AB\sin 37.5°}{\sin 105°} = 9.21(\text{cm})$ (A1) 3

(c) (i) Area $\Delta OBP = \frac{1}{2} \times 12 \times 9.21 \left(\text{or } \frac{1}{2} \times 12 \times 12 \tan 37.5°\right)$ (M1)

$= 55.3\ (\text{cm}^2)$ (accept $55.2\ \text{cm}^2$) (A1)

(ii) Area $\Delta ABP = \frac{1}{2}(9.21)^2 \sin 105°$ (M1)

$= 41.0\ (\text{cm}^2)$ (accept $40.9\ \text{cm}^2$) (A1) 4

(d) Area of sector $= \frac{1}{2} \times 12^2 \times 75 \times \frac{\pi}{180}\left(\text{or } \frac{75}{360} \times \pi \times 12^2\right)$ (M1)

$= 94.2\ (\text{cm}^2)$ (accept 30π or $94.3\ (\text{cm}^2)$) (A1) 2

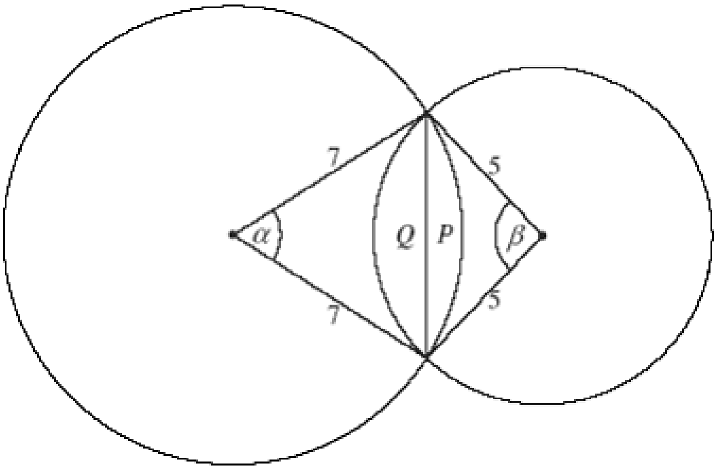
(e) Shaded area $= 2 \times$ area ΔOPB – area sector (M1)

$= 16.4\ (\text{cm}^2)$ (accept $16.2\ \text{cm}^2$, $16.3\ \text{cm}^2$) (A1) 2

[13]

LEVEL 3

1)



$\alpha = 2\arcsin\left(\frac{4.5}{7}\right)(\Rightarrow \alpha = 1.396... = 80.010° ...)$ M1(A1)

$\beta = 2\arcsin\left(\frac{4.5}{5}\right)(\Rightarrow \beta = 2.239... = 128.31°...)$ (A1)

Note: Allow use of cosine rule.

area $P = \frac{1}{2} \times 7^2 \times (\alpha - \sin\alpha) = 10.08...$ M1(A1)

area $Q = \frac{1}{2} \times 5^2 \times (\beta - \sin\beta) = 18.18...$ (A1)

Note: The M1 is for an attempt at area of sector minus area of triangle.

Note: The use of degrees correctly converted is acceptable.

area = 28.3(cm^2) A1

[7]

2)

area of triangle POQ = $\frac{1}{2}8^2 \sin 59°$ M1

$= 27.43$ (A1)

area of sector = $\pi 8^2 \frac{59}{360}$ M1

$= 32.95$ (A1)

area between arc and chord = 32.95 – 27.43

= 5.52 (cm^2) A1

[5]

3)

$A = \frac{\theta}{2}(R^2 - r^2)$	A1	
$B = \frac{\theta}{2}r^2$	A1	
from A: B = 2:1, we have $R^2 - r^2 = 2r^2$	M1	
$R = \sqrt{3}r$	(A1)	
hence exact value of the ratio $R : r$ is $\sqrt{3}$:1	A1	N0

[5]

4)

AC = AB = 10 (cm)	A1
triangle OBC is equilateral	(M1)
BC = 6 (cm)	A1
EITHER	
$\hat{BAC} = 2\arcsin\frac{3}{10}$	M1A1
$\hat{BAC}$ = 34.9° (accept 0.609 radians)	A1
OR	
$\cos \hat{BAC} = \frac{10^2 + 10^2 - 6^2}{2\times10\times10} = \frac{164}{200}$	M1A1
$\hat{BAC}$ = 34.9° (accept 0.609 radians)	A1

Note: Other valid methods may be seen.

[6]

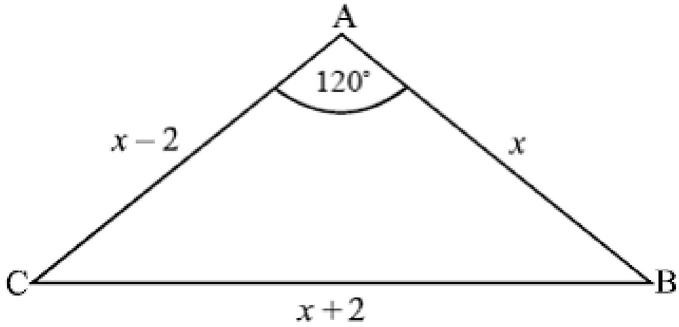
5)

PR = h tan 55°, QR = h tan 50° where RS = h	M1A1A1
Use the cosine rule in triangle PQR.	(M1)
$20^2 = h^2 \tan^2 55° + h^2 \tan^2 50° - 2h \tan 55°\, h \tan 50° \cos 45°$	A1
$h^2 = \frac{400}{\tan^2 55° + \tan^2 50° - 2\tan 55° \tan 50° \cos 45°}$	(A1)
= 379.9...	(A1)
h = 19.5 (m)	A1

[8]

6)

(a)



	(M1)
$(x+2)^2 = (x-2)^2 + x^2 - 2(x-2)\,x\cos 120°$	M1A1
$x^2 + 4x + 4 = x^2 - 4x + 4 + x^2 + x^2 - 2x$	(M1)
$0 = 2x^2 - 10x$	A1
$0 = x(x-5)$	
$x = 5$	A1

(b)

Area $= \frac{1}{2} \times 5 \times 3 \times \sin 120°$	M1A1
$= \frac{1}{2} \times 15 \times \frac{\sqrt{3}}{2}$	A1
$= \frac{15\sqrt{3}}{4}$	AG

(c)

$\sin A = \frac{\sqrt{3}}{2}$	
$\frac{15\sqrt{3}}{4} = \frac{1}{2} \times 5 \times 7 \times \sin B \Rightarrow \sin B = \frac{3\sqrt{3}}{14}$	M1A1
Similarly $\sin C = \frac{5\sqrt{3}}{14}$	A1
$\sin A + \sin B + \sin C = \frac{15\sqrt{3}}{14}$	A1

[13]