HIGHER

7.13 The Cosine Rule: 2-hour Pack

EDEXCEL 1MA1 · Calculator allowed · about 120 minutes

Total Marks

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

The Cosine Rule: Fluency and Exam Drill

Revision Library original resource, written for Edexcel 1MA1 (Higher tier)

The cosine rule connects the three sides of a triangle with one of its angles. For a triangle with sides a, b and c, and angle A opposite side a:

a^2 = b^2 + c^2 - 2*b*c*cos(A)

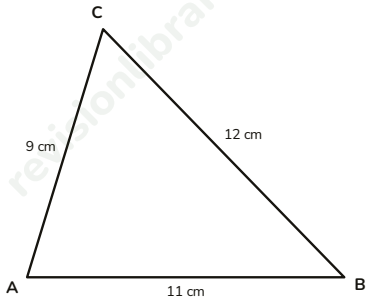
Rearranged to find an angle when all three sides are known:

cos(A) = (b^2 + c^2 - a^2) / (2*b*c)

Use the cosine rule whenever you know two sides and the included angle (to find the third side), or all three sides (to find any angle). A calculator is allowed and expected throughout; give lengths correct to 3 significant figures and angles correct to 1 decimal place unless told otherwise. Questions 1 to 14 build fluency with the rule in both directions. Questions 15 to 20 apply it to exam-style problems, including bearings, perimeters, a combined area calculation, a two-triangle quadrilateral problem and an algebraic setup. The final two questions are grade 9 stretch problems requiring an exact surd answer and multi-step reasoning.

1 In triangle ABC, BC = 12 cm, AC = 9 cm and AB = 11 cm. Work out the exact value of cos A. Give your answer as a fraction in its simplest form.

Diagram NOT accurately drawn

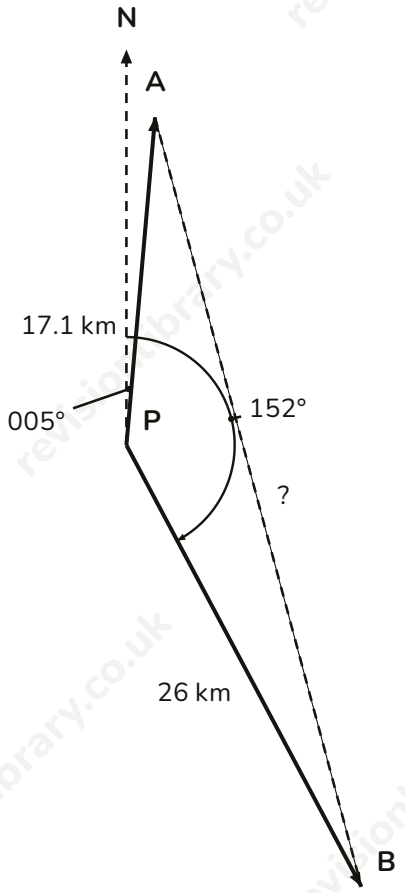


(Total for Question 1 is 3 marks)

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2 Two ships leave port P at the same time. Ship A sails 17.1 km on a bearing of 005 degrees. Ship B sails 26 km on a bearing of 152 degrees. Work out the distance between the two ships. Give your answer correct to 3 significant figures.

Diagram NOT accurately drawn

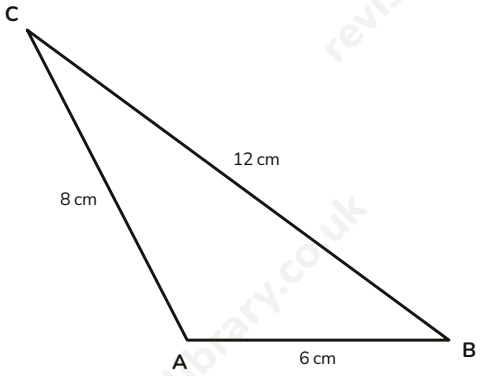


(Total for Question 2 is 4 marks)

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3 In triangle ABC, BC = 12 cm, AC = 8 cm and AB = 6 cm. Work out the exact value of cos A. Give your answer as a fraction in its simplest form.

Diagram NOT accurately drawn

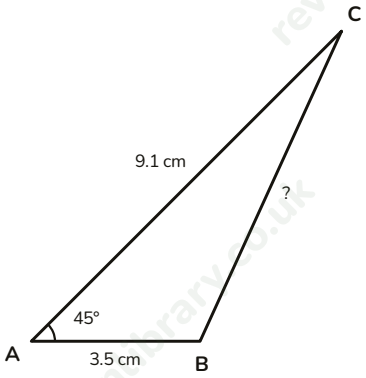


(Total for Question 3 is 3 marks)

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4 In triangle ABC, AC = 9.1 cm, AB = 3.5 cm and angle BAC = 45 degrees. Work out the length of BC. Give your answer correct to 3 significant figures.

Diagram NOT accurately drawn

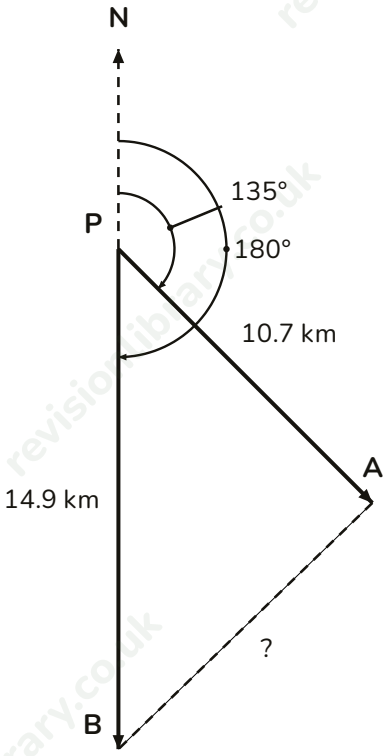


(Total for Question 4 is 3 marks)

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5 Two ships leave port P at the same time. Ship A sails 10.7 km on a bearing of 135 degrees. Ship B sails 14.9 km on a bearing of 180 degrees. Work out the distance between the two ships. Give your answer correct to 3 significant figures.

Diagram NOT accurately drawn

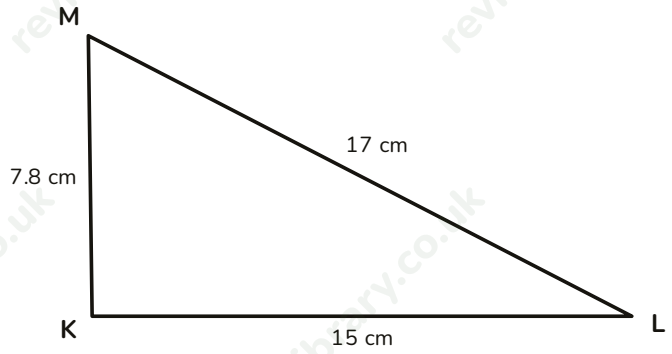


(Total for Question 5 is 4 marks)

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6 In triangle KLM, LM = 17 cm, KM = 7.8 cm and KL = 15 cm. Work out the size of angle LKM. Give your answer correct to 1 decimal place.

Diagram NOT accurately drawn

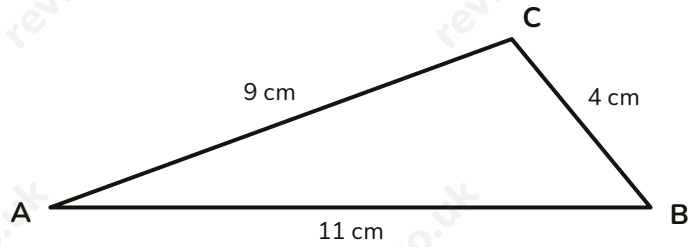


(Total for Question 6 is 3 marks)

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7 In triangle ABC, BC = 4 cm, AC = 9 cm and AB = 11 cm. Work out the exact value of cos A. Give your answer as a fraction in its simplest form.

Diagram NOT accurately drawn

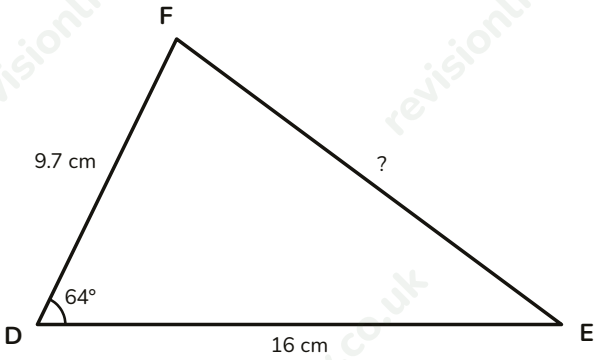


(Total for Question 7 is 3 marks)

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8 In triangle DEF, DF = 9.7 cm, DE = 16 cm and angle EDF = 64 degrees. Work out the length of EF. Give your answer correct to 3 significant figures.

Diagram NOT accurately drawn

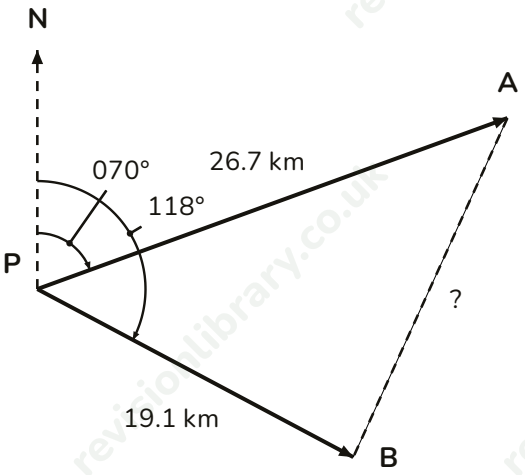


(Total for Question 8 is 3 marks)

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9 Two ships leave port P at the same time. Ship A sails 26.7 km on a bearing of 070 degrees. Ship B sails 19.1 km on a bearing of 118 degrees. Work out the distance between the two ships. Give your answer correct to 3 significant figures.

Diagram NOT accurately drawn

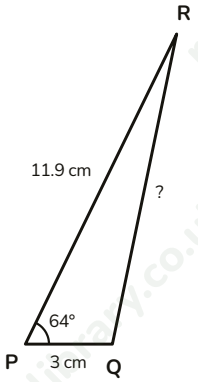


(Total for Question 9 is 4 marks)

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10 In triangle PQR, PR = 11.9 cm, PQ = 3 cm and angle QPR = 64 degrees. Work out the length of QR. Give your answer correct to 3 significant figures.

Diagram NOT accurately drawn

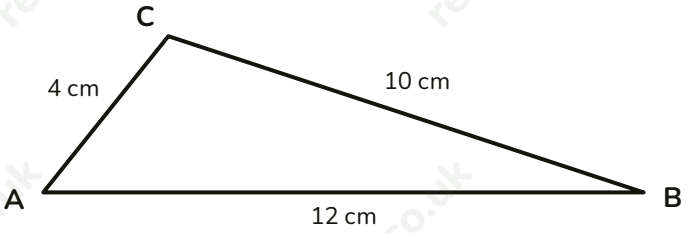


(Total for Question 10 is 3 marks)

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11 In triangle ABC, BC = 10 cm, AC = 4 cm and AB = 12 cm. Work out the exact value of cos A. Give your answer as a fraction in its simplest form.

Diagram NOT accurately drawn

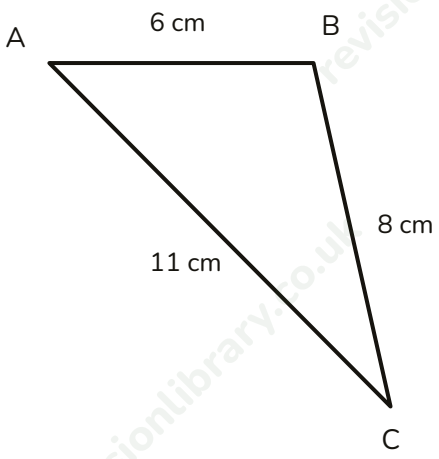


(Total for Question 11 is 3 marks)

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12 In triangle ABC, AB = 6 cm, BC = 8 cm and CA = 11 cm.

Diagram NOT accurately drawn



(a) Calculate the size of angle B. Give your answer correct to 1 decimal place. **(3)**

.....

(b) Using your answer to part (a), calculate the area of triangle ABC. Give your answer correct to 3 significant figures. **(3)**

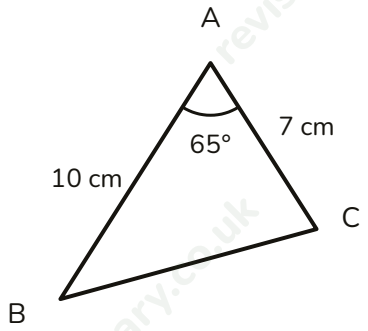
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(Total for Question 12 is 6 marks)

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13 In triangle ABC, angle A = 65 degrees, AB = 10 cm and AC = 7 cm.

Diagram NOT accurately drawn



(a) Calculate the length of BC. Give your answer correct to 3 significant figures. **(3)**

.....

(b) Calculate the size of angle ABC. Give your answer correct to 1 decimal place. **(3)**

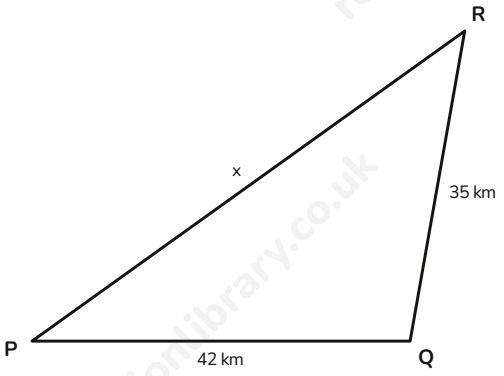
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(Total for Question 13 is 6 marks)

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14 A ship's captain, Priya, sails from port P to point Q, a distance of 42 km, on a bearing of 070 degrees. She then sails from Q to point R, a distance of 35 km, on a bearing of 150 degrees. Calculate the distance PR. Give your answer correct to 3 significant figures.

Diagram NOT accurately drawn

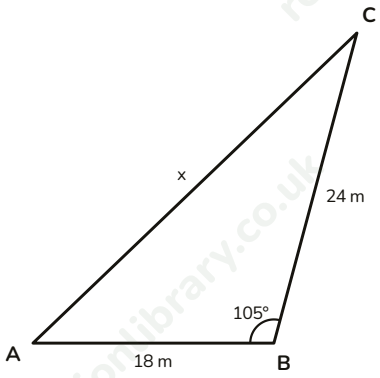


(Total for Question 14 is 4 marks)

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15 Amara is edging a triangular garden plot ABC. AB = 18 m, BC = 24 m and angle ABC = 105 degrees. Calculate the total length of edging needed to go around the whole perimeter of the plot. Give your answer correct to 3 significant figures.

Diagram NOT accurately drawn

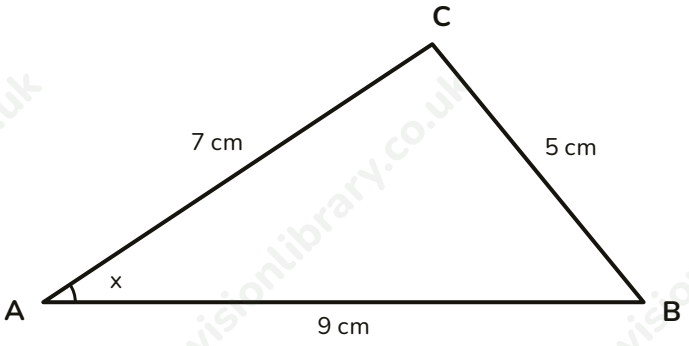


(Total for Question 15 is 4 marks)

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16 Triangle ABC has AB = 9 cm, AC = 7 cm and BC = 5 cm. Calculate the size of angle BAC. Give your answer correct to 1 decimal place.

Diagram NOT accurately drawn

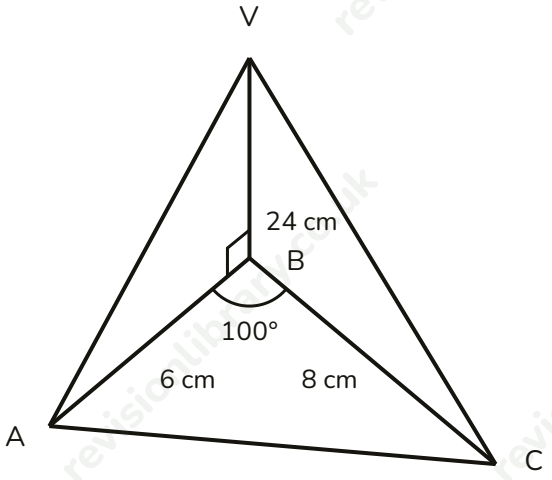


(Total for Question 16 is 3 marks)

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17 VABC is a tetrahedron on a horizontal base ABC, with VB perpendicular to the plane ABC. In the base, AB = 6 cm, BC = 8 cm and angle ABC = 100 degrees. The edge VB = 24 cm.

Diagram NOT accurately drawn



(a) Calculate the length of AC. Give your answer correct to 3 significant figures. **(3)**

.....

(b) Calculate the size of angle AVC. Give your answer correct to 1 decimal place. **(4)**

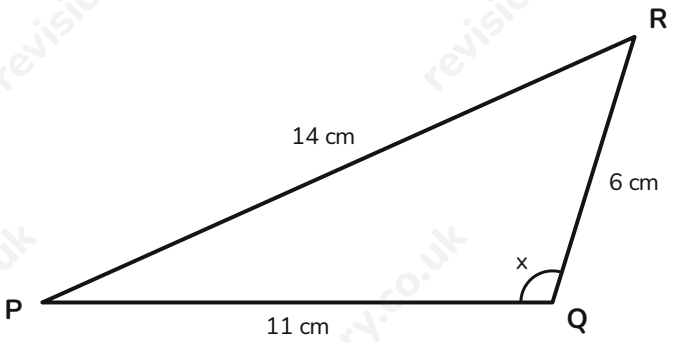
.....

(Total for Question 17 is 7 marks)

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18 Triangle PQR has PQ = 11 cm, QR = 6 cm and PR = 14 cm.

Diagram NOT accurately drawn



(a) Calculate the size of angle PQR. Give your answer correct to 1 decimal place. **(3)**

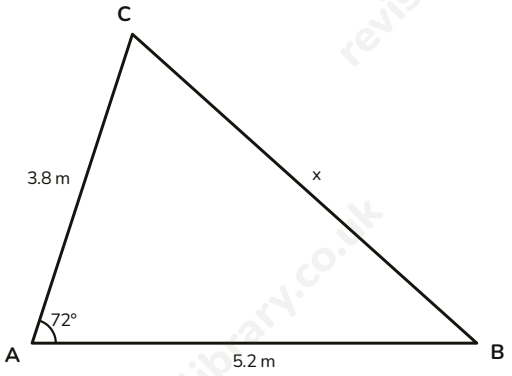
(b) Hence, without further calculation, state whether triangle PQR is acute-angled, right-angled or obtuse-angled. Give a reason for your answer. **(1)**

(Total for Question 18 is 4 marks)

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19 Liam is making a triangular sail for a small dinghy. Two sides of the sail measure 5.2 m and 3.8 m, with an angle of 72 degrees between them.

Diagram NOT accurately drawn



(a) Calculate the length of the third side of the sail. Give your answer correct to 3 significant figures. **(3)**

.....

(b) Calculate the area of the sail. Give your answer correct to 3 significant figures. **(2)**

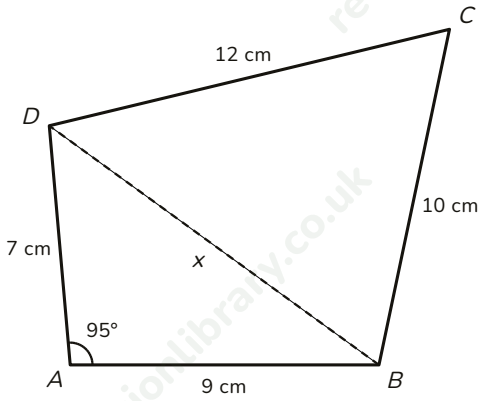
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(Total for Question 19 is 5 marks)

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20 Quadrilateral ABCD is made up of two triangles, ABD and BCD, joined along the diagonal BD. In triangle ABD, AB = 9 cm, AD = 7 cm and angle BAD = 95 degrees. In triangle BCD, BC = 10 cm and CD = 12 cm.

Diagram NOT accurately drawn



(a) Calculate the length of BD. Give your answer correct to 3 significant figures. **(3)**

.....

(b) Using an unrounded value of BD^2 from part (a), calculate the size of angle BCD. Give your answer correct to 1 decimal place. **(3)**

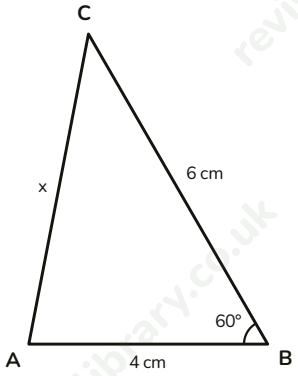
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(Total for Question 20 is 6 marks)

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21 Triangle ABC has AB = 4 cm, BC = 6 cm and angle ABC = 60 degrees. Show that AC = $2*\sqrt{7}$ cm.

Diagram NOT accurately drawn

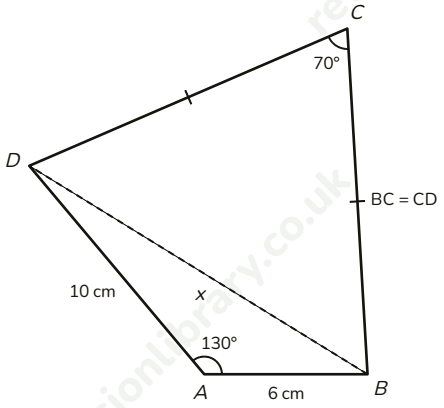


(Total for Question 21 is 3 marks)

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22 Quadrilateral ABCD is made up of two triangles, ABD and BCD, joined along the diagonal BD. In triangle ABD, AB = 6 cm, AD = 10 cm and angle BAD = 130 degrees. Triangle BCD is isosceles with BC = CD, and angle BCD = 70 degrees.

Diagram NOT accurately drawn



(a) Calculate the length of BD. Give your answer correct to 3 significant figures. **(3)**

.....

(b) Using an unrounded value of BD^2 from part (a), and the fact that triangle BCD is isosceles with BC = CD, calculate the length of BC. Give your answer correct to 3 significant figures. **(4)**

.....

(Total for Question 22 is 7 marks)

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Mark scheme · 7.13 The Cosine Rule: 2-hour Pack

Question 1

cosine rule with correct values	**M1**
cos A = 58/198	**M1**
29/99 oe	**A1**

Answer: 29/99

Question 2

angle between the two paths = 147 degrees	**B1**
cosine rule with correct values	**M1**
evaluates the square of the distance	**M1**
41.4 km cao	**A1**

Answer: 41.4 km

Question 3

cosine rule with correct values	**M1**
cos A = -44/96	**M1**
-11/24 oe	**A1**

Answer: -11/24

Question 4

$a^2 = 9.1^2 + 3.5^2 - 2 \times 9.1 \times 3.5 \times \cos 45$	**M1**
$a^2 = 50.017$ evaluated	**M1**
7.07 cm cao	**A1**

Answer: 7.07 cm

Question 5

angle between the two paths = 45 degrees	**B1**
cosine rule with correct values	**M1**
evaluates the square of the distance	**M1**
10.5 km cao	**A1**

Answer: 10.5 km

Question 6

$\cos A = (b^2 + c^2 - a^2)/(2bc)$ with correct values	**M1**
cos A = -0.0135 or equivalent	**M1**
90.8 degrees cao	**A1**

Answer: 90.8 degrees

Question 7

cosine rule with correct values	**M1**
cos A = 186/198	**M1**
31/33 oe	**A1**

Answer: 31/33

Question 8

$a^2 = 9.7^2 + 16^2 - 2 \times 9.7 \times 16 \times \cos 64$	**M1**
$a^2 = 214.020$ evaluated	**M1**
14.6 cm cao	**A1**

Answer: 14.6 cm

Question 9

angle between the two paths = 48 degrees	**B1**
cosine rule with correct values	**M1**
evaluates the square of the distance	**M1**
19.9 km cao	**A1**

Answer: 19.9 km

Question 10

$a^2 = 11.9^2 + 3^2 - 2 \times 11.9 \times 3 \times \cos 64$	**M1**
$a^2 = 119.310$ evaluated	**M1**
10.9 cm cao	**A1**

Answer: 10.9 cm

Question 11

cosine rule with correct values	**M1**
cos A = 60/96	**M1**
5/8 oe	**A1**

Answer: 5/8

Question 12

(a) $\cos B = (6^2+8^2-11^2)/(2 \times 6 \times 8)$ oe	**M1**
(a) cosB = -0.219 awrt (dep)	**M1**
(a) 102.6 degrees awrt	**A1**

(a) Answer: 102.6 degrees (1 dp)

(b) Area = 0.5 x 6 x 8 x sin(their B) oe ft	**M1**
(b) sin(102.6) = 0.976 awrt used (dep)	**M1**
(b) 23.4 cm² awrt (ft their B)	**A1**

(b) Answer: 23.4 cm^2 (3 sf)

Question 13

(a) $BC^2 = 10^2 + 7^2 - 2 \times 10 \times 7 \times \cos 65$ oe	**M1**
(a) $BC^2 = 89.8$ awrt (dep)	**M1**
(a) 9.48 cm awrt	**A1**

(a) Answer: 9.48 cm (3 sf)

(b) sin(ABC)/7 = sin65/their BC oe ft	**M1**
(b) sin(ABC) = 7 x sin65 / their BC (dep, ft)	**M1**
(b) 42.0 degrees awrt (ft their BC)	**A1**

(b) Answer: 42.0 degrees (1 dp)

Question 14

angle PQR = 100 degrees (bearing of P from Q is 070+180 = 250 degrees; angle PQR = 250-150 = 100 degrees)	**B1**
correct substitution into the cosine rule, e.g. $PR^2 = 42^2 + 35^2 - 2*42*35*\cos(100)$	**M1**
$PR^2 = 3500$ (awrt 3499-3500)	**A1**
PR = 59.2 km (awrt 59.1-59.2)	**A1**

Answer: PR = 59.2 km (3 s.f.)

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Question 15

correct substitution, e.g. $AC^2 = 18^2 + 24^2 - 2*18*24*\cos(105)$ **M1**

AC = 33.5 m (awrt 33.5) **A1**

adds all three sides to find the perimeter (ft their AC), e.g. perimeter = 18 + 24 + their AC **M1**

perimeter = 75.5 m (awrt 75.5) **A1**

Answer: Perimeter = 75.5 m (3 s.f.)

Question 16

correct rearrangement/substitution, e.g. $\cos(BAC) = (7^2+9^2-5^2)/(2*7*9)$ **M1**

cos(BAC) = 105/126 oe (awrt 0.833) **M1**

angle BAC = 33.6 degrees (awrt 33.5-33.6) **A1**

Answer: Angle BAC = 33.6 degrees (1 d.p.)

Question 17

(a) $AC^2 = 6^2 + 8^2 - 2 \times 6 \times 8 \times \cos 100$ oe **M1**

(a) $AC^2 = 117$ awrt (dep) **M1**

(a) 10.8 cm awrt **A1**

(a) Answer: 10.8 cm (3 sf)

(b) recognises right angles at B (VB perpendicular to plane), so $VA^2 = 24^2+6^2$ (=612) and $VC^2 = 24^2+8^2$ (=640), using Pythagoras **M1**

(b) $\cos(AVC) = (612 + 640 - \text{their } AC^2) / (2 \times \sqrt{612} \times \sqrt{640})$ oe ft **M1**

(b) cos(AVC) = 0.907 awrt (dep, ft) **M1**

(b) 24.9 degrees awrt (ft their AC) **A1**

(b) Answer: 24.9 degrees (1 dp)

Question 18

(a) correct substitution, e.g. $\cos(PQR) = (11^2+6^2-14^2)/(2*11*6)$ **M1**

(a) cos(PQR) = -39/132 oe (awrt -0.295) **A1**

(a) angle PQR = 107.2 degrees (awrt 107.1-107.2) **A1**

(a) Answer: Angle PQR = 107.2 degrees (1 d.p.)

(b) obtuse-angled (ft their angle from part (a)), because angle PQR (awrt 107 degrees) is greater than 90 degrees, oe (equivalently, because cos(PQR) is negative) **B1**

(b) Answer: Obtuse-angled (angle PQR > 90 degrees)

Question 19

(a) correct substitution, e.g. $side^2 = 5.2^2 + 3.8^2 - 2*5.2*3.8*\cos(72)$ **M1**

(a) $side^2 = 29.3$ (awrt 29.2-29.3) **A1**

(a) side = 5.41 m (awrt 5.41) **A1**

(a) Answer: Third side = 5.41 m (3 s.f.)

(b) area = 0.5*5.2*3.8*sin(72) oe **M1**

(b) 9.40 m² (awrt 9.39-9.40) **A1**

(b) Answer: Area = 9.40 m^2 (3 s.f.)

Question 20

(a) correct substitution, e.g. $BD^2 = 9^2 + 7^2 - 2*9*7*\cos(95)$ **M1**

(a) $BD^2 = 141$ (awrt 140.9-141.0) **A1**

(a) BD = 11.9 cm (awrt 11.9) **A1**

(a) Answer: BD = 11.9 cm (3 s.f.)

(b) correct substitution using their unrounded BD^2, e.g. $\cos(BCD) = (10^2+12^2-BD^2)/(2*10*12)$ **M1**

(b) cos(BCD) = 0.429 oe (awrt 0.429), ft their BD^2 **A1**

(b) angle BCD = 64.6 degrees (awrt 64.5-64.6) **A1**

(b) Answer: Angle BCD = 64.6 degrees (1 d.p.)

Question 21

correct substitution, e.g. $AC^2 = 4^2 + 6^2 - 2*4*6*\cos(60)$ **M1**

$AC^2 = 28$ oe (using cos(60) = 1/2 exactly, e.g. 16+36-24) **M1**

$AC = \sqrt{28} = 2*\sqrt{7}$ cm (cso, must be given in this exact simplified surd form) **A1**

Answer: AC = $2*\sqrt{7}$ cm (exact)

Question 22

(a) correct substitution, e.g. $BD^2 = 6^2 + 10^2 - 2*6*10*\cos(130)$ **M1**

(a) $BD^2 = 213$ (awrt 213.0-213.2) **A1**

(a) BD = 14.6 cm (awrt 14.6) **A1**

(a) Answer: BD = 14.6 cm (3 s.f.)

(b) correct isosceles cosine rule relationship, e.g. $BD^2 = BC^2+BC^2-2*BC*BC*\cos(70) = 2*BC^2*(1-\cos(70))$ **M1**

(b) correct rearrangement, e.g. $BC^2 = BD^2 / (2*(1-\cos(70)))$, dependent on previous method mark **M1**

(b) $BC^2 = 162$ (awrt 161.9-162.0), ft their BD^2 **A1**

(b) BC = 12.7 cm (awrt 12.7) **A1**

(b) Answer: BC = 12.7 cm (3 s.f.)

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