HIGHER

7.13 The Cosine Rule: Test Pack

EDEXCEL 1MA1 · Calculator allowed · about 60 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)

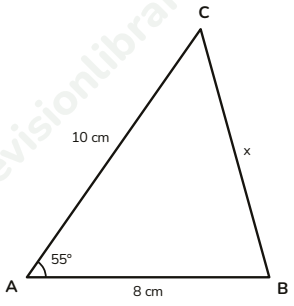
Rearranged to find an angle when all three sides are known:

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, AB = 8 cm, AC = 10 cm and angle BAC = 55 degrees. Calculate the length of BC. Give your answer correct to 3 significant figures.

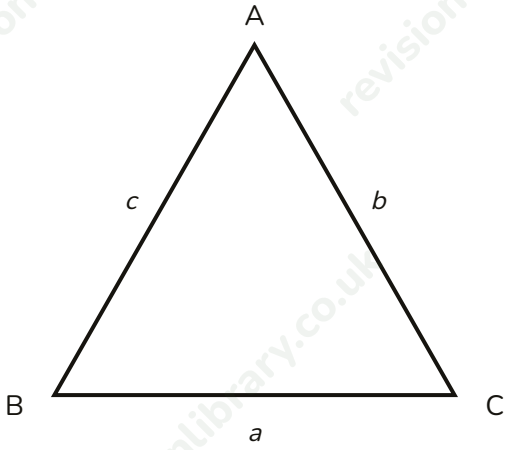
Diagram NOT accurately drawn



(Total for Question 1 is 2 marks)

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2 In triangle ABC, angle A is opposite side a, angle B is opposite side b, and angle C is opposite side c. Which equation correctly applies the cosine rule to find side a?



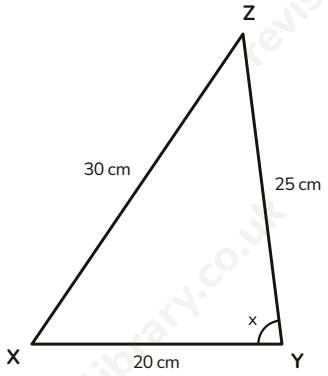
- ☐ A) $a^2 = b^2 + c^2 - 2bc \times \cos A$
- ☐ B) $a^2 = b^2 + c^2 + 2bc \times \cos A$
- ☐ C) $a = b^2 + c^2 - 2bc \times \cos A$
- ☐ D) $a^2 = b^2 - c^2 - 2bc \times \cos A$

(Total for Question 2 is 1 mark)

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3 Triangle XYZ has XY = 20 cm, YZ = 25 cm and XZ = 30 cm. Work out the size of angle XYZ. Give your answer correct to 1 decimal place.

Diagram NOT accurately drawn

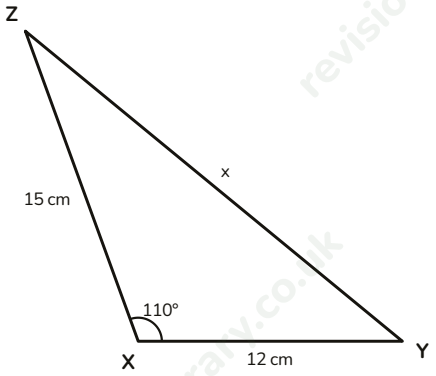


(Total for Question 3 is 2 marks)

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4 In triangle XYZ, XY = 12 cm, XZ = 15 cm and angle YXZ = 110 degrees. Work out the length of YZ. Give your answer correct to 3 significant figures.

Diagram NOT accurately drawn

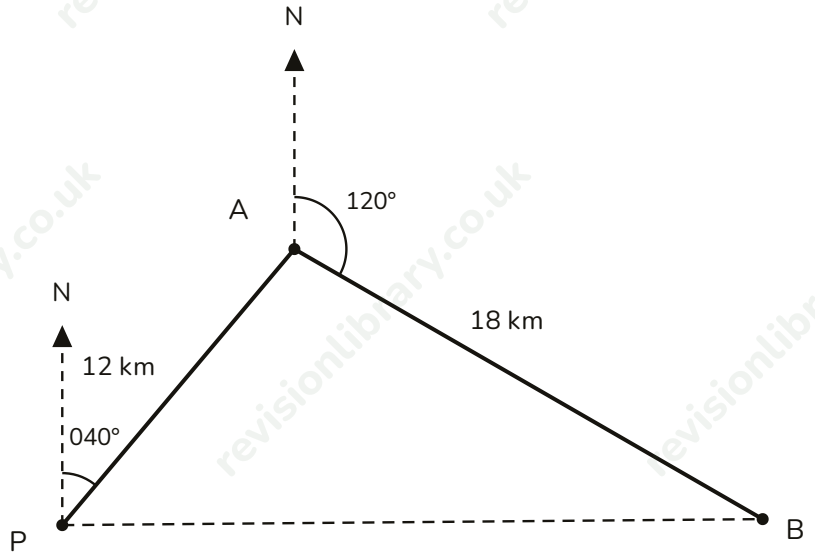


(Total for Question 4 is 2 marks)

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5 A boat sails from port P on a bearing of 040 degrees for 12 km to point A. It then changes course and sails on a bearing of 120 degrees for 18 km to point B. Calculate the direct distance from P to B. Give your answer to 3 significant figures.

Diagram NOT accurately drawn



(Total for Question 5 is 4 marks)

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6 Jayden is finding the size of angle X in a triangle with sides 7 cm, 9 cm and 12 cm, where X is the angle opposite the 12 cm side. His working is shown below:

$\cos X = (7^2 + 9^2 - 12^2) / (2 \times 7 \times 9)$

$\cos X = (49+81-144)/126$

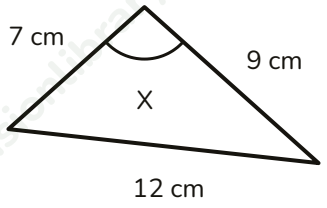
$\cos X = -14/126$

$X = \cos^{-1}(-14/126)$

$X = 83.6$ degrees

Jayden's final answer is wrong.

Diagram NOT accurately drawn



(a) Identify the error in Jayden's working. **(1)**

(b) Work out the correct value of X. Give your answer correct to 1 decimal place. **(2)**

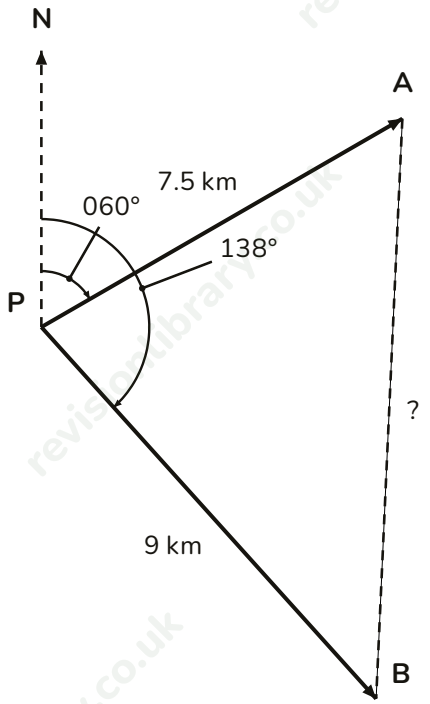
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(Total for Question 6 is 3 marks)

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7 Two ships leave port P at the same time. Ship A sails 7.5 km on a bearing of 060 degrees. Ship B sails 9 km on a bearing of 138 degrees. Work out the distance between the two ships. Give your answer correct to 3 significant figures.

Diagram NOT accurately drawn

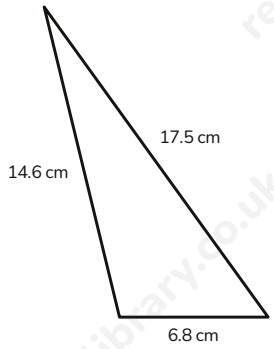


(Total for Question 7 is 4 marks)

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8 The sides of a triangle are 6.8 cm, 14.6 cm and 17.5 cm. Work out the size of the largest angle in the triangle. Give your answer correct to 1 decimal place.

Diagram NOT accurately drawn

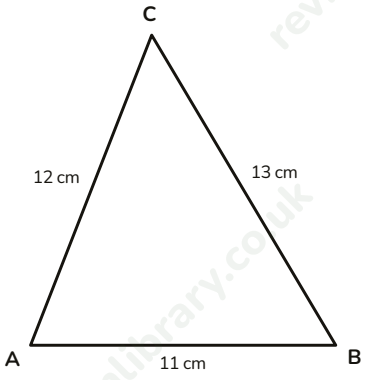


(Total for Question 8 is 3 marks)

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9 In triangle ABC, BC = 13 cm, AC = 12 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



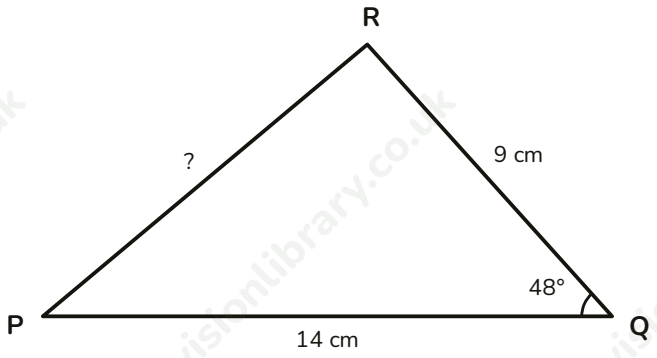
(Total for Question 9 is 3 marks)

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10 For each triangle described below, state whether the sine rule or the cosine rule should be used to find the unknown length, and give a reason.

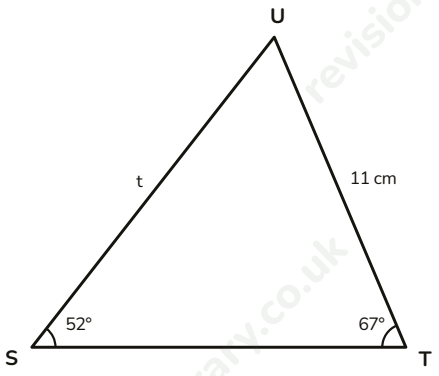
(a) Triangle PQR has PQ = 14 cm, QR = 9 cm, angle PQR = 48 degrees, and PR is unknown. State which rule should be used to find PR, and give a reason. **(1)**

Diagram NOT accurately drawn



(b) Triangle STU has angle S = 52 degrees, side s = 11 cm (opposite angle S), and angle T = 67 degrees, with side t unknown. State which rule should be used to find t, and give a reason. **(1)**

Diagram NOT accurately drawn

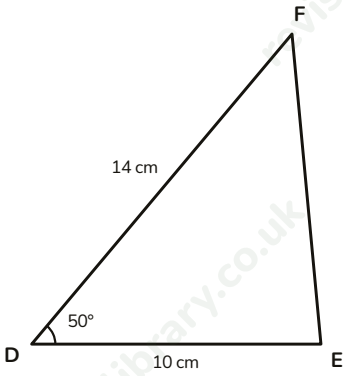


(Total for Question 10 is 2 marks)

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11 In triangle DEF, DE = 10 cm, DF = 14 cm and angle EDF = 50 degrees. Show that the length of EF is 10.8 cm, correct to 3 significant figures.

Diagram NOT accurately drawn

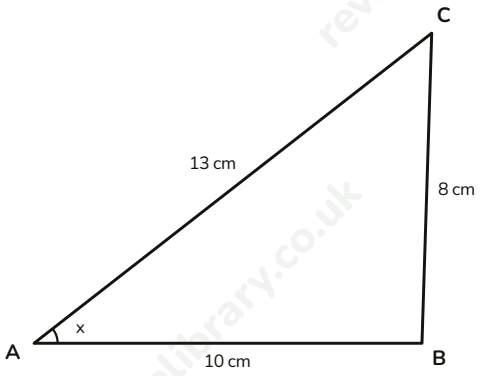


(Total for Question 11 is 3 marks)

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12 Triangle ABC has AB = 10 cm, AC = 13 cm and BC = 8 cm. Calculate the size of angle BAC. Give your answer correct to 1 decimal place.

Diagram NOT accurately drawn

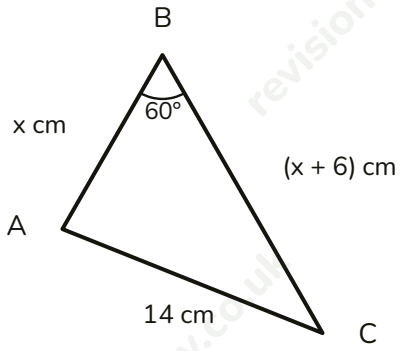


(Total for Question 12 is 3 marks)

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13 In triangle ABC, AB = x cm, BC = (x + 6) cm, angle ABC = 60 degrees and AC = 14 cm.

Diagram NOT accurately drawn



(a) Show that $x^2 + 6x - 160 = 0$. **(4)**

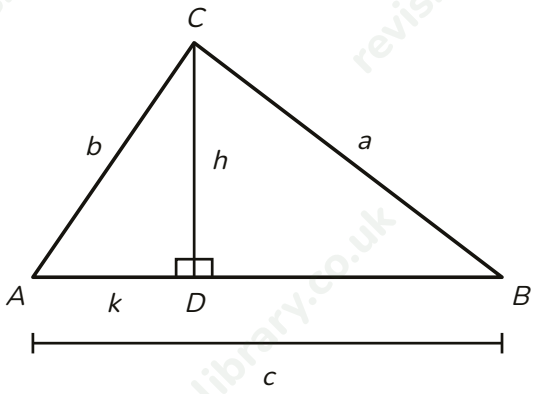
(b) Hence find the value of x, giving a reason for rejecting any invalid solution. **(3)**

(Total for Question 13 is 7 marks)

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14 Triangle ABC has angle A less than 90 degrees. The perpendicular from C meets AB at point D, with CD = h and AD = k. Prove that $a^2 = b^2 + c^2 - 2bc\cos A$.

Diagram NOT accurately drawn



(Total for Question 14 is 4 marks)

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Mark scheme · 7.13 The Cosine Rule: Test Pack

Question 1

correct substitution, e.g. $BC^2 = 8^2 + 10^2 - 2*8*10*\cos(55)$ oe	**M1**
BC = 8.50 cm (awrt 8.50), cao	**A1**

Answer: BC = 8.50 cm (3 s.f.)

Question 2

A oe	**B1**

Answer: A) $a^2 = b^2 + c^2 - 2bc \times \cos A$

Question 3

correct substitution, e.g. $\cos(XYZ) = (20^2+25^2-30^2)/(2*20*25) = 125/1000 = 0.125$ oe	**M1**
angle XYZ = 82.8 degrees (awrt 82.7-82.8)	**A1**

Answer: Angle XYZ = 82.8 degrees (1 d.p.)

Question 4

correct substitution, e.g. $YZ^2 = 12^2 + 15^2 - 2*12*15*\cos(110)$ oe	**M1**
YZ = 22.2 cm (awrt 22.2), cao	**A1**

Answer: YZ = 22.2 cm (3 s.f.)

Question 5

angle PAB = 100 degrees (bearing back to P is 040+180=220, and 220-120=100)	**B1**
$PB^2 = 12^2 + 18^2 - 2 \times 12 \times 18 \times \cos 100$ oe	**M1**
$PB^2 = 543$ awrt (dep)	**M1**
23.3 km awrt	**A1**

Answer: 23.3 km (3 sf)

Question 6

(a) he evaluated $\cos^{-1}$ of the positive value 0.1111 instead of the negative value -0.1111, so found the acute angle instead of the obtuse angle oe	**B1**

(a) Answer: He found $\cos^{-1}(14/126)$ instead of $\cos^{-1}(-14/126)$, giving the acute angle instead of the required obtuse angle.

(b) $X = \cos^{-1}(-14/126)$ oe	**M1**
(b) 96.4 degrees awrt	**A1**

(b) Answer: 96.4 degrees (1 dp)

Question 7

angle between the two paths = 78 degrees	**B1**
cosine rule with correct values	**M1**
evaluates the square of the distance	**M1**
10.4 km cao	**A1**

Answer: 10.4 km

Question 8

identifies the largest angle as opposite the longest side	**M1**
cosine rule with correct values	**M1**
103.6 degrees cao	**A1**

Answer: 103.6 degrees

Question 9

cosine rule with correct values	**M1**
cos A = 96/264	**M1**
4/11 oe	**A1**

Answer: 4/11

Question 10

(a) cosine rule, because two sides and the included angle (SAS) are known oe	**B1**

(a) Answer: Cosine rule, because two sides and the angle between them are known (SAS).

(b) sine rule, because a complete angle-opposite-side pair (S and s) is known along with another angle oe	**B1**

(b) Answer: Sine rule, because a full angle-side pair (S and s) is known along with another angle (T).

Question 11

$EF^2 = 10^2 + 14^2 - 2 \times 10 \times 14 \times \cos 50$ oe	**M1**
$EF^2 = 116$ awrt (dep)	**M1**
EF = 10.8 cm cso (answer given, all working shown)	**A1**

Answer: 10.8 cm (answer given)

Question 12

correct rearrangement/substitution, e.g. $\cos(BAC) = (10^2+13^2-8^2)/(2*10*13)$	**M1**
cos(BAC) = 205/260 oe (awrt 0.788)	**M1**
angle BAC = 38.0 degrees (awrt 38.0)	**A1**

Answer: Angle BAC = 38.0 degrees (1 d.p.)

Question 13

(a) $14^2 = x^2 + (x+6)^2 - 2 \times x \times (x+6) \times \cos 60$ oe	**M1**
(a) correctly expands $(x+6)^2 = x^2+12x+36$ and uses $\cos 60=0.5$ so $2x(x+6)(0.5)=x(x+6)=x^2+6x$	**M1**
(a) $196 = x^2+x^2+12x+36-x^2-6x$, i.e. $196 = x^2+6x+36$ (dep)	**M1**
(a) $x^2+6x-160=0$ cso (fully rearranged, answer given)	**A1**

(a) Answer: $x^2 + 6x - 160 = 0$ (answer given)

(b) solves $x^2+6x-160=0$, e.g. $(x+16)(x-10)=0$ or quadratic formula	**M1**
(b) x=10 or x=-16 (both values seen)	**A1**
(b) rejects x=-16 since a length cannot be negative, so x=10 cm cao	**B1**

(b) Answer: x = 10 cm

Question 14

in right triangle ADC, $h = b \times \sin A$ and $k = b \times \cos A$ (using AC = b)	**M1**
states $BD = c - k = c - b \cos A$ (using AB = c) and applies Pythagoras in triangle BDC: $a^2 = h^2 + BD^2$	**M1**
expands $a^2 = (b \sin A)^2 + (c - b \cos A)^2 = b^2 \sin^2 A + c^2 - 2bc \cos A + b^2 \cos^2 A$	**M1**
uses $\sin^2 A + \cos^2 A = 1$ to simplify to $a^2 = b^2 + c^2 - 2bc \cos A$ cso (proof complete)	**A1**

Answer: $a^2 = b^2 + c^2 - 2bc \cos A$ (proven)

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