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| **UNIT 13: Sine and cosine rules, *ab* sin *C*, trigonometry and Pythagoras’ Theorem in 3D, trigonometric graphs, and accuracy and bounds** |

[Return to Overview](#HOverview)

**SPECIFICATION REFERENCES**

N16 apply and interpret limits of accuracy, **including upper and lower bounds**

A5 understand and use standard mathematical formulae; rearrange formulae to change the subject

A8 work with coordinates in all four quadrants

A12 recognise, sketch and interpret graphs of linear functions, quadratic functions, simple cubic functions, the reciprocal function  with *x* ≠ 0, **exponential, functions   
*y* = *kx* for positive values of *k*, and the trigonometric functions (with arguments in degrees) *y* = sin *x*, *y* = cos *x* and *y* = tan *x* for angles of any size**

A13 **sketch translations and reflections of a given function**

G11 solve geometrical problems on coordinate axes

G20 know the formulae for: Pythagoras’ Theorem *a*2 + *b*2 = *c*2 and the trigonometric ratios, sine, cosine and tan; apply them to find angles and lengths in right-angled triangles **and, where possible, general triangles** in two **and three** dimensional figures

G21 know the exact values of sin *θ* and cos *θ* for *θ* = 0°, 30°, 45° , 60° and 90°; know the exact value of tan *θ* for *θ* = 0°, 30°, 45° and 60°

G22 **know and apply the sine rule**  **=**  **=** **, and cosine rule   
*a*2 = *b*2 + *c*2 – 2*bc* cos *A*, to find unknown lengths and angles**

G23 **know and apply Area = *ab* sin *C* to calculate the area, sides or angles of any triangle**

**PRIOR KNOWLEDGE**

Students should be able to use axes and coordinates to specify points in all four quadrants.

Students should be able to recall and apply Pythagoras’ Theorem and trigonometric ratios.

Students should be able to substitute into formulae.

**KEYWORDS**

Axes, coordinates, sine, cosine, tan, angle, graph, transformations, side, angle, inverse, square root, 2D, 3D, diagonal, plane, cuboid

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| **13b. Further trigonometry**  (N16, A5, A8, G11, G20, G22, G23 ) | **Teaching time**  8-10 hours |

**OBJECTIVES**

By the end of the sub-unit, students should be able to:

* Know and apply Area = *ab* sin *C* to calculate the area, sides or angles of any triangle.
* Know the sine and cosine rules, and use to solve 2D problems (including involving bearings).
* Use the sine and cosine rules to solve 3D problems.
* Understand the language of planes, and recognise the diagonals of a cuboid.
* Solve geometrical problems on coordinate axes.
* Understand, recall and use trigonometric relationships and Pythagoras’ Theorem in right-angled triangles, and use these to solve problems in 3D configurations.
* Calculate the length of a diagonal of a cuboid.
  + Find the angle between a line and a plane.

**POSSIBLE SUCCESS CRITERIA**

Find the area of a segment of a circle given the radius and length of the chord.

Justify when to use the cosine rule, sine rule, Pythagoras’ Theorem or normal trigonometric ratios to solve problems.

**OPPORTUNITIES FOR REASONING/PROBLEM SOLVING**

Triangles formed in a semi-circle can provide links with other areas of mathematics.

**COMMON MISCONCEPTIONS**

Not using the correct rule, or attempting to use ‘normal trig’ in non-right-angled triangles.

When finding angles students will be unable to rearrange the cosine rule or fail to find the inverse of cos *θ*.

**NOTES**

The cosine rule is used when we have SAS and used to find the side opposite the ‘included’ angle or when we have SSS to find an angle.

Ensure that finding angles with ‘normal trig’ is refreshed prior to this topic.

Students may find it useful to be reminded of simple geometrical facts, i.e. the shortest side is always opposite the shortest angle in a triangle.

The sine and cosine rules and general formula for the area of a triangle are not given on the formulae sheet.

In multi-step questions emphasise the importance of not rounding prematurely and using exact values where appropriate.

Whilst 3D coordinates are not included in the programme of study, they provide a visual introduction to trigonometry in 3D.