MA99 EDUCATION

Focus area 4 Trigonometry: Summary

04

NSW MATHEMATICS STANDARD 11-12 SYLLABUS 2024 FOR HSC 2027 AND LATER

Trigonometry, on three pages

Right-angled triangles

$$\sin\theta = \frac{\text{opp}}{\text{hyp}}, \quad \cos\theta = \frac{\text{adj}}{\text{hyp}}, \quad \tan\theta = \frac{\text{opp}}{\text{adj}}, \qquad c^2 = a^2 + b^2$$

Name opposite and adjacent from the angle in use. Unknown side on top: multiply. Unknown side underneath: divide. Unknown angle: inverse ratio. $1^\circ = 60'$; decimal part $\times 60$ gives minutes: $44.6056^\circ \approx 44^\circ 36'$, $52^\circ 36' = 52.6^\circ$.

Any triangle (Standard 2)

Rule	Formula	Use it when	On reference sheet?
Sine rule, side	$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$	a side with its opposite angle, and another angle	Yes
Sine rule, angle	$\frac{\sin A}{a} = \frac{\sin B}{b} = \frac{\sin C}{c}$	a complete pair and another side; ambiguous case excluded	No
Cosine rule, side	$c^2 = a^2 + b^2 - 2ab\cos C$	two sides and the angle between	Yes
Cosine rule, angle	$\cos C = \frac{a^2 + b^2 - c^2}{2ab}$	three sides	Yes
Area	$A = \frac{1}{2}ab\sin C$	two sides and the included angle	Yes

Obtuse angle by the sine rule (the question will say it is obtuse): find the acute angle θ with $\sin^{-1}$, then the answer is $180^\circ - \theta$, since $\sin(180^\circ - \theta) = \sin\theta$. A **negative cosine** in the cosine rule means an obtuse angle, and $\cos^{-1}$ handles it.

Bearings

True bearing	Compass bearing	Example
0° to 90°	$\text{N}\theta\text{E}$	$060^\circ\text{T} = \text{N}60^\circ\text{E}$
90° to 180°	$\text{S}(180-\theta)\text{E}$	$145^\circ\text{T} = \text{S}35^\circ\text{E}$
180° to 270°	$\text{S}(\theta-180)\text{W}$	$237^\circ\text{T} = \text{S}57^\circ\text{W}$
270° to 360°	$\text{N}(360-\theta)\text{W}$	$310^\circ\text{T} = \text{N}50^\circ\text{W}$

True bearings: clockwise from north, three digits, T. The reverse bearing differs by 180°. Draw a north line at every turning point; parallel north lines give alternate and co-interior angles.

Radial surveys (Standard 2)

From a central point O: a bearing and a distance to each corner. Angle at O between two corners = difference of their bearings (add 360° across north). **Area**: add $\frac{1}{2} \times d_1 d_2 \sin(\text{angle at O})$ for every triangle. **Perimeter**: cosine rule for each boundary edge, then add.

Elevation and depression

Both measured from the horizontal. Depression from the top equals elevation from below (alternate angles). Lines of sight start at eye level: subtract the eye height first.

The methods, as recipes

Task	Recipe
Choose a rule	Right angle: ratios. Complete pair: sine rule. Otherwise: cosine rule.
Find an angle safely	Use the cosine rule when you have three sides; the sine rule only for an angle you know is acute, or one you are told is obtuse.
Two triangle problem	Find the shared side in the first triangle, keep it unrounded, finish in the second.
Bearings problem	North lines everywhere; interior angle from bearings; solve the triangle; convert the angle you find back to a bearing from north.
Radial survey	Angles at O by subtraction; area rule per triangle; cosine rule per edge.

Each rule in one line

Rule	A typical use, from the notes
Sine ratio	$h = 9.6 \sin 4°30' \approx 0.75$ m (Worked example 1)
Inverse tangent	$\tan\theta = \frac{3}{40}$, $\theta \approx 4°17'$ (Worked example 2)
Sine rule, side	$PB = \dfrac{850 \sin 71°}{\sin 51°} \approx 1034$ m (Worked example 3)
Sine rule, obtuse angle	$\sin Q \approx 0.8632$ $Q \approx 180 - 59°41' = 120°19'$ (Worked example 5)
Cosine rule, side	$d^2 = 6.4^2 + 8.1^2 - 2(6.4)(8.1)\cos 47°$, $d \approx 6.0$ km (Worked example 6)
Cosine rule, angle	$\cos C = \frac{45^2+62^2-80^2}{2(45)(62)}$, $C \approx 95°28'$ (Worked example 7)
Area	$\frac{1}{2}(4.8)(5.5)\sin 64° \approx 11.86$ m^2 (Worked example 8)
Bearing from a triangle	$65° + 55.22° \approx 120°$T (Worked example 12)

Common errors

1. Calculator in radian mode.
2. Decimal degrees read as minutes: $35.25° = 35°15'$.
3. Pairing a side with the wrong angle in the sine rule.
4. Stopping at the acute angle when the question says obtuse.
5. Area rule with an angle that is not between the two sides.
6. Angle of depression measured from the vertical.
7. An interior angle given as a bearing.
8. Rounding a side early, then using it.

Checklist

- [ ] Find a side or an angle in a right-angled triangle, in degrees and minutes
- [ ] Find an obtuse angle with the sine rule when told it is obtuse
- [ ] Use the sine rule for a side and for an acute angle
- [ ] Use both forms of the cosine rule

- [ ] Find an area with $A = \frac{1}{2}ab\sin C$, and find an angle from an area
- [ ] Convert between true and compass bearings, and find a reverse bearing
- [ ] Construct a radial survey and find its area and perimeter
- [ ] Solve elevation, depression, bearing and two triangle problems from a diagram

Standard 1

Standard 1 needs the right-angled ratios, degrees and minutes, Pythagoras, bearings, elevation and depression, and right-angled practical problems. The sine rule, cosine rule, area rule and radial surveys are Standard 2 only.

Where this sits

Focus area 4 of Year 12 Mathematics Standard 2, Trigonometry (outcome MST-12-S2-04: using trigonometry to solve problems in both right-angled and other triangles). NESA lists ten content points in one group, and this resource teaches them in NESA's order: right-angled triangles, the sine rule (three points), the cosine rule (two points), the area formula, bearings, radial surveys, then practical problems that combine them.

In NESA's Standard 2 sample paper for 2027, this focus area carries 12 of the 100 marks: a multiple choice item converting a compass bearing to a true bearing, a 4 mark item with two right-angled triangles answered to the nearest minute, a 4 mark item using $A = \frac{1}{2}ab\sin C$ inside a volume, and a 3 mark item that finds an angle by the cosine rule and then a bearing.

Written to the NSW Mathematics Standard 11-12 Syllabus (2024), the syllabus Year 12 studies from Term 4 2026, first examined in the 2027 HSC. Year 11 work is assumed, and HSC questions can draw on it.

About this resource

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Scope

NSW Mathematics Standard, Year 12. Written to the NSW Mathematics Standard 11-12 Syllabus (2024), Standard 2 focus area 4, Trigonometry (MST-12-S2-04), and for Standard 1 Right-angled triangles (MST-12-S1-04), for students sitting the HSC in 2027 and later years. Every value, identity and solution was re-derived independently by computer algebra before printing. Contexts in the questions are invented unless a source is named.

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