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ANSWER BOOK

Trigonometric graphs and equations

Trigonometry · Year 12–13

7 questions · 20 marks

NAVY EDITION

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SECTION A · Warm-up

A1 sin 30° = ½, cos 45° = √2/2, tan 60° = √3. All of them come from two triangles: the halved equilateral and the halved square. [2]

A2 The principal value is 60°, and cosine's symmetry supplies the partner 360° - 60° = 300°. So x = 60° or 300°: one root each side of the 360° line of symmetry. [2]

SECTION B · Standard

B1 The calculator's principal value is -30°, outside the interval; the graph puts the actual roots where sine is negative, in the third and fourth quadrants: x = 180° + 30° = 210° and 360° - 30° = 330°. [3]

B2 Replace $\sin^2 x$ with $1 - \cos^2 x$: $2 - 2\cos^2 x + \cos x - 1 = 0$, which tidies to $2\cos^2 x - \cos x - 1 = 0$ and factorises as (2 cos x + 1)(cos x - 1) = 0. cos x = 1 gives x = 0°; cos x = -½ gives x = 120° and 240°. Three solutions: 0°, 120°, 240°. [3]

B3 Gather and factorise: sin x (cos x - 2) = 0. The bracket can never be zero, since cosine never reaches 2, so the only route is sin x = 0: x = 0° or 180°. Dividing both sides by sin x at the start would have destroyed every solution the equation has. [3]

B4 Dividing by cos x is safe here, since cos x = 0 makes the left side ±3, not 0: tan x = 2/3, so x = 33.7° and, one half-turn along, 213.7°. Tangent repeats every 180°, so a tan equation always gives two roots in a 360° window. [3]

SECTION C · Stretch

C1 Let θ = x - 40°, so θ runs over -40° ≤ θ < 320° while x covers its interval. cos θ = ½ at θ = 60° and 300°, and also at -60°, which the widened interval excludes (-60° < -40°). Translating back: x = 100° or 340°. Widening the interval before hunting roots is the whole discipline; solving first and shifting after loses or invents solutions. [4]

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