Answer 1:

1. (a) Let N be North

$\text{N}\hat{\text{J}}\text{D} = 34°$ OR $\text{D}\hat{\text{J}}\text{L} = 56°$ (must be labelled or indicated in diagram): ***(A1)***

$\text{J}\hat{\text{D}}\text{L} = 99(°)$ ***A1***

Note: Accept $\frac{11\pi}{20}, 1.73$ (radians).

[2 marks]

(b) attempt to apply the sine rule ***(M1)***

$\frac{\text{DL}}{\sin 56°} = \frac{500}{\sin 99°}$ OR $\frac{\text{DL}}{\sin 0.977384...} = \frac{500}{\sin 1.72787...}$ ***(A1)***

$419.685\ldots$

$\text{DL} = 420$ (km) ***A1***

Note: Award ***M1A1A0*** for 261 (km) from use of degrees with GDC set in radians (with or without working).

[3 marks]

Total [5 marks]

Answer 2:

9. (a) (i) attempt to use the cosine rule ***(M1)***

$$\mathrm{AC} = \sqrt{2^2 + 4^2 - 2(2)(4)\cos\alpha} \left(= \sqrt{20 - 16\cos\alpha} = 2\sqrt{5 - 4\cos\alpha} \right)$$ ***A1***

(ii) $$\mathrm{AC} = \sqrt{6^2 + 8^2 - 2(6)(8)\cos\beta} \left(= \sqrt{100 - 96\cos\beta} = 2\sqrt{25 - 24\cos\beta} \right)$$ ***A1***

(iii) $5 - 4\cos\alpha = 25 - 24\cos\beta$

$\alpha = \arccos(6\cos\beta - 5)$ ***A1***

[4 marks]

(b) attempt to find the sum of two triangle areas using $A = \frac{1}{2}ab\sin C$ ***(M1)***

Note: Do not award this ***M1*** if the triangle is assumed to be right angled.

$\text{Area} = \frac{1}{2}(8)\sin\alpha + \frac{1}{2}(48)\sin\beta$ ***(A1)***

attempt to express the area in terms of one variable only ***(M1)***

$= 4\sqrt{1 - (6\cos\beta - 5)^2} + 24\sin\beta$ or $4\sin(\arccos(6\cos\beta - 5)) + 24\sin\beta$ OR

$4\sin\alpha + 24\sqrt{1 - \left(\frac{5+\cos\alpha}{6}\right)^2}$ or $4\sin\alpha + 24\sin\left(\arccos\left(\frac{5+\cos\alpha}{6}\right)\right)$

Max area $= 19.5959\ldots$

$= 19.6$ ***A1***

[4 marks]

Total [8 marks]

Answer 3:

3. (a) $(f \circ g)(x) = f(2x)$ ***(A1)***

$f(2x) = \sqrt{3}\sin 2x + \cos 2x$ ***A1***

[2 marks]

(b) $\sqrt{3}\sin 2x + \cos 2x = 2\cos 2x$

$\sqrt{3}\sin 2x = \cos 2x$

recognizing to use $\tan$ or $\cot$ ***M1***

$\tan 2x = \frac{1}{\sqrt{3}}$ OR $\cot 2x = \sqrt{3}$ (values may be seen in right triangle) ***(A1)***

$\left(\arctan\left(\frac{1}{\sqrt{3}}\right) =\right) \frac{\pi}{6}$ (seen anywhere) (accept degrees) ***(A1)***

$2x = \frac{\pi}{6}, \frac{7\pi}{6}$

$x = \frac{\pi}{12}, \frac{7\pi}{12}$ ***A1A1***

Note:	Do not award the final ***A1*** if any additional solutions are seen.
	Award ***A1A0*** for correct answers in degrees.
	Award ***A0A0*** for correct answers in degrees with additional values.

[5 marks]

Total [7 marks]

Answer 4:

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9. $(\sin 2x - \sin x) - (\cos 2x - \cos x) = 1$

attempt to use both double-angle formulae, in whatever form ***M1***

$(2\sin x \cos x - \sin x) - (2\cos^2 x - 1 - \cos x) = 1$

or $(2\sin x \cos x - \sin x) - \left(2\cos^2 x - \cos x\right) = 0$ for example ***A1***

Note: Allow any rearrangement of the above equations.

$\sin x(2\cos x - 1) - \cos x(2\cos x - 1) = 0$

$(\sin x - \cos x)(2\cos x - 1) = 0$ ***(M1)***

$\tan x = 1$ and $\cos x = \frac{1}{2}$ ***A1A1***

Note: These ***A*** marks are dependent on the ***M*** mark awarded for factorisation.

$x = -\frac{3\pi}{4}, -\frac{\pi}{3}, \frac{\pi}{3}, \frac{\pi}{4}$ ***A2***

Note: Award ***A1*** for two correct answers, which could be for both tan or both cos solutions, for example.

[7 marks]

Answer 5:

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3. $\tan(x+\pi) = \tan x \left(= \frac{\sin x}{\cos x}\right)$ ***(M1)A1***

$\cos\left(x - \frac{\pi}{2}\right) = \sin x$ ***(M1)A1***

Note: The two ***M1***'s can be awarded for observation or for expanding.

$\tan(x+\pi)\cos\left(x - \frac{\pi}{2}\right) = \frac{\sin^2 x}{\cos x}$ ***A1***

[5 marks]

Answer 6:

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(a) **METHOD 1**

$$\text{LHS} = \frac{1+\sin 2x}{\cos 2x} = \frac{1+2\sin x\cos x}{\cos^2 x - \sin^2 x}$$ ***M1***

$$= \frac{\left(\cos^2 x + \sin^2 x\right) + 2\sin x\cos x}{\cos^2 x - \sin^2 x}$$ ***M1***

$$= \frac{\left(\cos x + \sin x\right)^2}{\left(\cos x + \sin x\right)\left(\cos x - \sin x\right)}$$ ***A1***

$$= \frac{\cos x + \sin x}{\cos x - \sin x}$$

$$= \frac{\frac{\cos x}{\cos x} + \frac{\sin x}{\cos x}}{\frac{\cos x}{\cos x} - \frac{\sin x}{\cos x}}$$ ***A1***

$$= \frac{1+\tan x}{1-\tan x}$$ ***AG***

Note: Candidates may start with RHS, apply MS in reverse.

[4 marks]

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METHOD 2

$$\text{LHS} = \frac{1+\sin 2x}{\cos 2x} = \frac{1+2\sin x\cos x}{\cos^2 x - \sin^2 x}$$ ***M1***

dividing numerator and denominator by $\cos^2 x$ ***M1***

$$= \frac{\sec^2 x + 2\tan x}{1-\tan^2 x}$$

$$= \frac{1+\tan^2 x + 2\tan x}{1-\tan^2 x}$$ ***A1***

$$= \frac{(\tan x + 1)^2}{(1-\tan x)(1+\tan x)}$$ ***A1***

$$= \frac{1+\tan x}{1-\tan x}$$ ***AG***

Note: Candidates may start with RHS; apply MS in reverse.

[4 marks]

(b) valid attempt to solve $\frac{1+\tan x}{1-\tan x} = \sqrt{3}$ ***(M1)***

$$\tan x = \frac{\sqrt{3}-1}{\sqrt{3}+1}$$

$$x = 0.262\left(=\frac{\pi}{12}\right),\ x = 3.40\left(=\frac{13\pi}{12}\right)$$ ***A1***

Note: Award ***M1A0*** if only one correct solution is given.

[2 marks]

Total [6 marks]

Answer 7:

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5. (a) $\cos x = 0, \sin x = 0$ *(M1)*

$x = \frac{n\pi}{2}, n \in \mathbb{Z}$ *A1*

[2 marks]

(b) **EITHER**

$\frac{\sin 3x \cos x - \cos 3x \sin x}{\sin x \cos x}$ *M1A1*

$= \frac{\sin(3x - x)}{\frac{1}{2}\sin 2x}$ *A1A1*

$= 2$ *A1*

OR

$\frac{\sin 2x \cos x + \cos 2x \sin x}{\sin x} - \frac{\cos 2x \cos x - \sin 2x \sin x}{\cos x}$ *M1*

$= \frac{2\sin x \cos^2 x + 2\cos^2 x \sin x - \sin x}{\sin x} - \frac{2\cos^3 x - \cos x - 2\sin^2 x \cos x}{\cos x}$ *A1A1*

$= 4\cos^2 x - 1 - 2\cos^2 x + 1 + 2\sin^2 x$ *A1*

$= 2\cos^2 x + 2\sin^2 x$

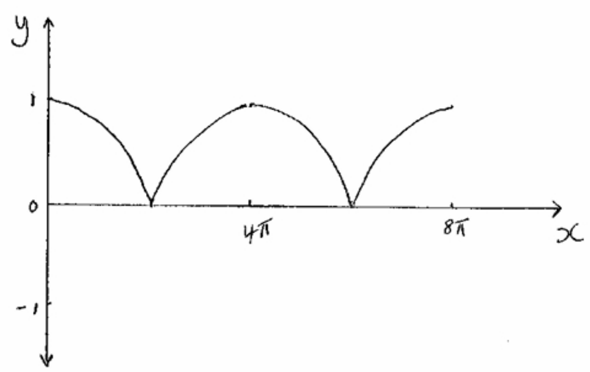
$= 2$ *A1*

[5 marks]

Total [7 marks]

Answer 8:

5. (a)



A1A1

Note: Award ***A1*** for correct shape and ***A1*** for correct domain and range.

[2 marks]

(b) $\left|\cos\left(\frac{x}{4}\right)\right| = \frac{1}{2}$

$x = \frac{4\pi}{3}$ ***A1***

attempting to find any other solutions ***M1***

Note: Award ***(M1)*** if at least one of the other solutions is correct (in radians or degrees) or clear use of symmetry is seen.

$x = 8\pi - \frac{4\pi}{3} = \frac{20\pi}{3}$

$x = 4\pi - \frac{4\pi}{3} = \frac{8\pi}{3}$

$x = 4\pi + \frac{4\pi}{3} = \frac{16\pi}{3}$ ***A1***

Note: Award ***A1*** for all other three solutions correct and no extra solutions.

Note: If working in degrees, then max ***A0M1A0***.

[3 marks]

Total [5 marks]