QUESTION NUMBER

DO NOT WRITE IN THIS MARGIN

9.(a)

$$k\sin(x+a) = k\sin x\cos a + k\cos x\sin a$$

$$= k\cos a\sin x + k\sin a\cos x$$

$$= k\sin a\cos x + k\cos a\sin x$$

$$7\cos x - 3\sin x$$

$k\sin a = 7$

$k\cos a = -3$

$k = \sqrt{7^2+3^2}$

$k = \sqrt{58}$

$\tan a = \frac{7}{-3}$

$a = 113$

S ✓	A ✓
T ✓	C

$\tan^{-1}(a) = 67$

$$7\cos x - 3\sin x = \sqrt{58}\sin(x+113)^\circ$$

9.(b) (i)

$$14\cos x - 6\sin x$$

$$= 2(7\cos x - 3\sin x)$$

$$= 2\sqrt{58}\sin(x+113)^\circ$$

Max value $= 2\sqrt{58}$

9.(b) (ii)

$x + 113 = 90, 450$

$x = 337^\circ$

$0 \leq x < 360$

$113 \leq x+113 < 473$

Question			Generic scheme	Illustrative scheme	Max mark
9.	(a)		•1 use compound angle formula •2 compare coefficients •3 process for k •4 process for a and express in required form	•1 $k\sin x°\cos a° + k\cos x°\sin a°$ **stated explicitly** •2 $k\cos a° = -3,\ k\sin a° = 7$ **stated explicitly** •3 $\sqrt{58}$ •4 $\sqrt{58}\sin(x + 113.19\ldots)°$.	**4**

Notes:

1. Do not penalise the omission of degree symbols in this question.
2. Accept $k(\sin x°\cos a° + \cos x°\sin a°)$ at •1.
3. Treat $k\sin x°\cos a° + \cos x°\sin a°$ as bad form only if the equations at the •2 stage both contain k.
4. $\sqrt{58}\sin x°\cos a° + \sqrt{58}\cos x°\sin a°$ or $\sqrt{58}(\sin x°\cos a° + \cos x°\sin a°)$ are acceptable for •1 and •3.
5. •2 is not available for $k\cos x° = -3$ and $k\sin x° = 7$, however •4 may still be gained - see Candidate E.
6. •3 is only available for a single value of k, $k > 0$.
7. •4 is not available for a value of a given in radians.
8. Accept values of a which round to 113.
9. Candidates may use any form of the wave function for •1, •2 and •3. However, •4 is only available if the wave is interpreted in the form $k\sin(x + a)°$.
10. Evidence for •4 may appear in part (b).

Question	Generic scheme	Illustrative scheme	Max mark

9. (continued)

Commonly Observed Responses:

Candidate A

$\bullet^1$ ^

$\sqrt{58}\cos a° = -3$

$\sqrt{58}\sin a° = 7$ $\bullet^2$ ✓ $\bullet^3$ ✓

$\tan a° = -\frac{7}{3}$

$a = 113.19\ldots$

$\sqrt{58}\sin(x + 113.19\ldots)°$ $\bullet^4$ ✓

Candidate B

$k\sin x°\cos a° + k\cos x°\sin a°$ $\bullet^1$ ✓

$\cos a° = -3$

$\sin a° = 7$ $\bullet^2$ ✗

$\tan a° = -\frac{7}{3}$

$a = 113.19\ldots$

Not consistent with equations at $\bullet^2$.

$\sqrt{58}\sin(x + 113.19\ldots)°$ $\bullet^3$ ✓ $\bullet^4$ ✗

Candidate C

$\sin x°\cos a° + \cos x°\sin a°$ $\bullet^1$ ✗

$\cos a° = -3$

$\sin a° = 7$ $\bullet^2$ ✓2

$k = \sqrt{58}$ $\bullet^3$ ✓

$\tan a° = -\frac{7}{3}$

$a = 113.19\ldots$

$\sqrt{58}\sin(x + 113.19\ldots)°$ $\bullet^4$ ✗

Candidate D - errors at $\bullet^2$

$k\sin x\cos a + k\cos x\sin a$ $\bullet^1$ ✓

$k\cos a° = 7$

$k\sin a° = -3$ $\bullet^2$ ✗

$\tan a° = -\frac{3}{7}$

$a = 336.80\ldots$

$\sqrt{58}\sin(x + 336.80\ldots)°$ $\bullet^3$ ✓ $\bullet^4$ ✓1

Candidate E - use of x at $\bullet^2$

$k\sin x\cos a + k\cos x\sin a$ $\bullet^1$ ✓

$k\cos x° = -3$

$k\sin x° = 7$ $\bullet^2$ ✗

$\tan a° = -\frac{7}{3}$

$a = 113.19\ldots$

$\sqrt{58}\sin(x + 113.19\ldots)°$

$\bullet^3$ ✓ $\bullet^4$ ✓1

Candidate F

$k\sin A\cos B + k\cos A\sin B$ $\bullet^1$ ✗

$k\cos A = -3$

$k\sin A = 7$ $\bullet^2$ ✗

$\tan A = -\frac{7}{3}$

$A = 113.19\ldots$

$\sqrt{58}\sin(x + 113.19\ldots)°$ $\bullet^3$ ✓ $\bullet^4$ ✓1

Question			Generic scheme	Illustrative scheme	Max mark
9.	(b)	(i)	$\bullet^5$ state maximum value	$\bullet^5$ $2\sqrt{58}$	**1**
		(ii)	**Method 1** $\bullet^6$ start to solve $\bullet^7$ state value of x **Method 2** $\bullet^6$ start to solve $\bullet^7$ state value of x	**Method 1** $\bullet^6$ $x+113.19\ldots=90$ leading to $x=-23.19\ldots$ $\bullet^7$ $x=336.80\ldots$ **Method 2** $\bullet^6$ $x+113.19\ldots=450$ $\bullet^7$ $x=336.80\ldots$	**2**

Notes:

11. $\bullet^7$ is only available where an angle outwith the range $0\le x<360$ needs to be considered - see Candidate G.
12. $\bullet^7$ is only available where $\bullet^6$ has been awarded. However, see Candidate K.

Commonly Observed Responses:

Candidate G - not considering angle outwith $0\le x<360$

$\sqrt{58}\sin(x-23)°$ from part (a)

$x-23=90$ $\bullet^6$ ✓1

$x=113$ $\bullet^7$ ✓2

Candidate H - simplification

(i) $2\sqrt{58}$ $\bullet^5$ ✓

(ii) $\sqrt{58}\sin(x+113)°=\sqrt{58}$

$x+113=90$

$x=-23$ $\bullet^6$ ✓

$x=337$ $\bullet^7$ ✓

Candidate I - follow-through marking

(i) $\sqrt{58}$ $\bullet^5$ ✗

(ii) $2\sqrt{58}\sin(x+113)°=\sqrt{58}$

$x+113=30$

$x=-83$ $\bullet^6$ ✓1

$x=277$ $\bullet^7$ ✓1

Candidate J - graphical approach

(i) $\sqrt{58}$ $\bullet^5$ ✗

(ii) max occurs when $x+113=90$

$x=-23$ $\bullet^6$ ✓

$x=337$ $\bullet^7$ ✓

Candidate K - no acknowledgement of $\times 2$

(i) $\sqrt{58}$ $\bullet^5$ ✗

(ii) $\sqrt{58}\sin(x+113)°=\sqrt{58}$

$x+113=90$

$x=-23$ $\bullet^6$ ✗

$x=337$ $\bullet^7$ ✓1