Question	Scheme	Marks
1	$\int x\cos 3x\,\mathrm{d}x = \frac{1}{3}x\sin 3x - \frac{1}{3}\int \sin 3x\,\mathrm{d}x$	**M1**
	$= \frac{1}{3}x\sin 3x + \frac{1}{9}\cos 3x$	**dM1 A1**
	$\int_0^{\frac{\pi}{6}} x\cos 3x\,\mathrm{d}x = \left[\frac{1}{3}x\sin 3x + \frac{1}{9}\cos 3x\right]_0^{\frac{\pi}{6}} = \frac{1}{3}\frac{\pi}{6}\sin\frac{\pi}{2} + \frac{1}{9}\cos\frac{\pi}{2} - \left(0 + \frac{1}{9}\right)$	**M1**
	$= \frac{\pi}{18} - \frac{1}{9}$	**A1**
		(5)
		(5 marks)

M1: Applies integration by parts in the correct direction to achieve $\alpha x\sin 3x \pm \beta\int \sin 3x\,\mathrm{d}x$

So do not penalise the appearance of a '+' sign unless they state $\int vu'\mathrm{d}x = uv + \int uv'\mathrm{d}x$ o.e.

dM1: Completes the process by integrating the sin3x term, achieving $\pm\alpha x\sin 3x \pm \beta\cos 3x$

A1: Correct integration which may be left un simplified. E.g. $\frac{1}{3}x\sin 3x - \frac{1}{3}\left(-\frac{1}{3}\cos 3x\right)$

May have been done in stages (allow if $\frac{1}{3}x\sin 3x$ and $+\frac{1}{9}\cos 3x$ are seen on separate lines.)

Ignore spurious notation as long as the intention is clear.

M1: Applies both the limits to their integral which must be of the form $\pm\alpha x\sin 3x \pm \beta\cos 3x$. The substitution must be seen, or clearly implied by the correct evaluation of their $\pm\alpha x\sin 3x \pm \beta\cos 3x$

If embedded limits are not seen first, then $\left[\pm\alpha x\sin 3x \pm \beta\cos 3x\right]_0^{\frac{\pi}{6}} = (...) - \underline{0}$ is M0

Condone the subtraction being done either way around.

A1: Correct simplified answer. ISW after a correct answer. Allow $\frac{\pi - 2}{18}$

Alt methods may be seen. E.g. D & I method

Differentiation	Integration
x	$\cos 3x$
1	$\frac{1}{3}\sin 3x$
0	$-\frac{1}{9}\cos 3x$

Score M1 dM1 for sight of $\pm\alpha x\sin 3x \pm \beta\cos 3x$

Question	Scheme	Marks
2	$\overrightarrow{OA}=\begin{pmatrix}7\\2\\-5\end{pmatrix}$ $\overrightarrow{AB}=\begin{pmatrix}-2\\4\\3\end{pmatrix}$ $\overrightarrow{OC}=\begin{pmatrix}a\\5\\-1\end{pmatrix}$	
(a)	$\overrightarrow{OB}=\overrightarrow{OA}+\overrightarrow{AB}=\begin{pmatrix}7\\2\\-5\end{pmatrix}+\begin{pmatrix}-2\\4\\3\end{pmatrix}=...$	**M1**
	$=\begin{pmatrix}5\\6\\-2\end{pmatrix}$, $5\mathbf{i}+6\mathbf{j}-2\mathbf{k}$ or $(5,6,-2)$	**A1**
		(2)
(b)	$\overrightarrow{BC}=\overrightarrow{OC}-"\overrightarrow{OB}"=\begin{pmatrix}a\\5\\-1\end{pmatrix}-"\begin{pmatrix}5\\6\\-2\end{pmatrix}"=...$	**M1**
	$\overrightarrow{OC}."\overrightarrow{BC}"=0\Rightarrow\begin{pmatrix}a\\5\\-1\end{pmatrix}."\begin{pmatrix}a-5\\-1\\1\end{pmatrix}"=0\Rightarrow a(a-5)-5-1=0$	**dM1**
	$a^2-5a-6=0\Rightarrow(a-6)(a+1)=0\Rightarrow a=...$	**ddM1**
	$a=-1,\ 6$	**A1**
		(4)
		(6 marks)

(a)

M1: Attempts to add $\overrightarrow{OA}$ and $\overrightarrow{AB}$, which may be implied by two correct coordinates out of three if there is no direct statement as in the main scheme.

A1: Correct coordinates, in either vector or Cartesian form. (See main scheme).

Withhold the mark for hybrid versions such as $(5\mathbf{i},6\mathbf{j},-2\mathbf{k})$ but isw after you have seen a correct answer

(b)

M1: Attempts $\overrightarrow{BC}$ by subtracting their $\overrightarrow{OB}$ (look at their answer to (a)) and $\overrightarrow{OC}$, subtracted either way round, which may be implied by two correct coordinates out of three following through on their (a).

dM1: Applies the scalar product with $\overrightarrow{OC}$ and their $\overrightarrow{BC}$, sets equal to 0 and forms a quadratic equation in *a*. Dependent upon the previous M.

An alternative method is via Pythagoras' theorem $OC^2+BC^2=OB^2\Rightarrow$

$(a^2+5^2+1^2)+((a-5)^2+1^2+1^2)=5^2+6^2+(-2)^2\Rightarrow 2a^2-10a-12=0$

ddM1: Depends on both previous Ms. Solves their 3- term quadratic equation (which must have real roots) by any valid means including a calculator (check roots if done this way).

A1: Correct values for *a*. If the candidate goes on to reject a value it is A0.