Question Number	Scheme	Marks
10.	(a) $s = \sqrt{3}\sin\frac{\pi}{6} + \cos\frac{\pi}{6} = \sqrt{3}\times\frac{1}{2} + \frac{\sqrt{3}}{2}$	M1
	$= \sqrt{3}$	A1
	(b) At O, $s = 0$ so $\sqrt{3}\sin\frac{1}{2}t + \cos\frac{1}{2}t = 0$	
	$\Rightarrow \tan\frac{1}{2}t = -\frac{1}{\sqrt{3}}$	M1 A1
	$\Rightarrow \frac{1}{2}t = \frac{5\pi}{6}$	M1dep
	$\Rightarrow t = \frac{5\pi}{3}$	A1
	(c) $v = \frac{\mathrm{d}s}{\mathrm{d}t} = \frac{\sqrt{3}}{2}\cos\frac{t}{2} - \frac{1}{2}\sin\frac{t}{2}$	M1 A1
	(d) $\cos(\frac{\pi}{6} + \frac{t}{2}) = \cos\frac{\pi}{6}\cos\frac{t}{2} - \sin\frac{\pi}{6}\sin\frac{t}{2}$	M1
	$= \frac{\sqrt{3}}{2}\cos\frac{t}{2} - \frac{1}{2}\sin\frac{t}{2} = v$	A1
	(e) $\cos(\frac{\pi}{6} + \frac{t}{2}) = \frac{1}{2}$	
	$\Rightarrow \frac{\pi}{6} + \frac{t}{2} = \frac{\pi}{3}, \frac{5\pi}{3}, \cdots$	M1
	$\Rightarrow \frac{t}{2} = \cdots, \frac{\pi}{6}, \frac{9\pi}{6}, \cdots$ *or* $\frac{\pi}{3} + t = \cdots, \frac{2\pi}{3}, \frac{10\pi}{3}, \cdots$	
	$\Rightarrow t = \cdots, \frac{\pi}{3}, \frac{9\pi}{3}, \cdots$	M1dep
	(i) $t = \frac{\pi}{3}$	A1
	(ii) $t = 3\pi$	A1 (14)

Notes for Question 10

(a) M1 for substituting $\frac{\pi}{3}$ into the given expression for *s* and proceeding to a value or numerical expression (not necessarily correct) for *s*.

A1cao for $s=\sqrt{3}$ No decimal values must be seen in the working. This can be done on a calculator - if $\sqrt{3}$ is the only numerical value seen award M1A1, but if a decimal approximation is seen first and no substitution shown award M0A0.

(b) M1 for setting $s=0$ and rearranging to $k\tan\frac{1}{2}t=...$ where *k* is a number

A1 for $\tan\frac{1}{2}t=-\frac{1}{\sqrt{3}}$ oe

M1dep for obtaining a positive value for $\frac{1}{2}t$ or t (need not be exact and may be in degrees).

Should be correct for their $\tan\frac{1}{2}t$. Dependent on the first M mark in (b)

A1cao for identifying the required value as $\frac{5\pi}{3}$ (must be exact and in radians). Ignore any answers greater than $\frac{5\pi}{3}$. Award A0 if previous mark has been given for a decimal approx. Allow if the initial solution was in degrees and now changed to radians.

Alternative for (b):

$\tan\frac{\pi}{3}\sin\frac{1}{2}t+\cos\frac{1}{2}t=0$	
$\sin\frac{\pi}{3}\sin\frac{1}{2}t+\cos\frac{\pi}{3}\cos\frac{1}{2}t=0$	M1
$\cos\left(\frac{\pi}{3}-\frac{1}{2}t\right)=0$	A1
$\frac{\pi}{3}-\frac{1}{2}t=-\frac{1}{2}\pi,\ \frac{1}{2}\pi$	M1 (either, in degrees or radians)
$t=\frac{5\pi}{3}$	A1cao Ignore extras as above

Notes for Question 10 Continued

(c)

M1 for attempting the differentiation. cos should become sine **and** sine become cos. Allow if + between terms or $\frac{1}{2}$ missing but not if either term is multiplied by 2 (implies integration)

A1 for $v = \frac{\sqrt{3}}{2}\cos\frac{1}{2}t - \frac{1}{2}\sin\frac{1}{2}t$

(d)

M1 for expanding $\cos\left(\frac{\pi}{6} + \frac{1}{2}t\right)$ with the given formula Must show $\cos\frac{\pi}{6}\cos\frac{1}{2}t$ etc

A1 for using values for $\cos\frac{\pi}{6}$ and $\sin\frac{\pi}{6}$ to obtain *v*. *

If worked from $v = \frac{\sqrt{3}}{2}\cos\frac{1}{2}t - \frac{1}{2}\sin\frac{1}{2}t$, award M1 for changing $\frac{\sqrt{3}}{2}$, $\frac{1}{2}$ to trig functions **and** using the addition formula and A1 if everything is correct.

(e)

M1 for obtaining a value in radians for $\frac{\pi}{6} + \frac{1}{2}t$ - need not be exact

M1dep for obtaining a value for *t* - need not be exact

(i) A1cao for $t = \frac{\pi}{3}$ (ii) A1cao for $t = 3\pi$

Ignore labels (i) and (ii). If more values given ignore if outside the required ranges. Deduct one or both A1 marks for each extra solution seen within the range.

If starting from their result in (c), they need to reach $\cos\left(\frac{\pi}{6} + \frac{t}{2}\right) = \frac{1}{2}$ in order to make further progress, so award marks as for the main method.

NB: marks for (d) can only be given in (d).

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