| Question Number | Scheme | Marks |
|---|---|---|
| **5 (a)** | $D = 8 + 5\sin\left(\frac{\pi \times 2}{6} + 3\right) = 4.07$ | B1 |
| | | **(1)** |
| **(b)** | (b) $6 = 8 + 5\sin\left(\frac{\pi t}{6} + 3\right) \Rightarrow \sin\left(\frac{\pi t}{6} + 3\right) = -\frac{2}{5}$ | M1 , A1 |
| | $\Rightarrow \left(\frac{\pi t}{6} + 3\right) = \arcsin\left(-\frac{2}{5}\right) =$ Any of $3.55,\ 5.87, 9.84, 12.2$ | dM1 |
| | $\Rightarrow t =$ Any of $\frac{6(3.55-3)}{\pi}, \frac{6(5.87-3)}{\pi}, \frac{6(9.84-3)}{\pi}, \frac{6(12.2-3)}{\pi}$ | ddM1 |
| | 13:04 or 1:04 pm | A1 |
| | | **(5)** |
| | | **Total 6** |

(a)

B1: Scored for sight of $8 + 5\sin\left(\frac{\pi \times 2}{6} + 3\right)$ o.e followed by 4.06, $4.07$ or awrt 4.07. Units can be omitted

(b) It is acceptable to set $x = \frac{\pi t}{6} + 3$ which allows access to the first three marks

M1: Substitutes $D = 6$ and proceeds to $\sin\left(\frac{\pi t}{6} + 3\right) = k$

A1: $\sin\left(\frac{\pi t}{6} + 3\right) = -\frac{2}{5}$. o.e

dM1: Takes arcsin*k* where *k* < 0 and achieves any **correct positive value** for their arcsin*k*

Any of $3.55,\ 5.87, 9.84, 12.2$ are acceptable where $k = -\frac{2}{5}$ . Follow through on their $-1 < k < 0$

ddM1: Full and complete method to find a positive value of *t*

It is dependent upon both previous M's **AND** $k = -\frac{2}{5}$

Score for $t =$ Any of $\frac{6(3.55-3)}{\pi}, \frac{6(5.87-3)}{\pi}, \frac{6(9.84-3)}{\pi}, \frac{6(12.2-3)}{\pi}$

It can be implied for any *t* value to 3sf,

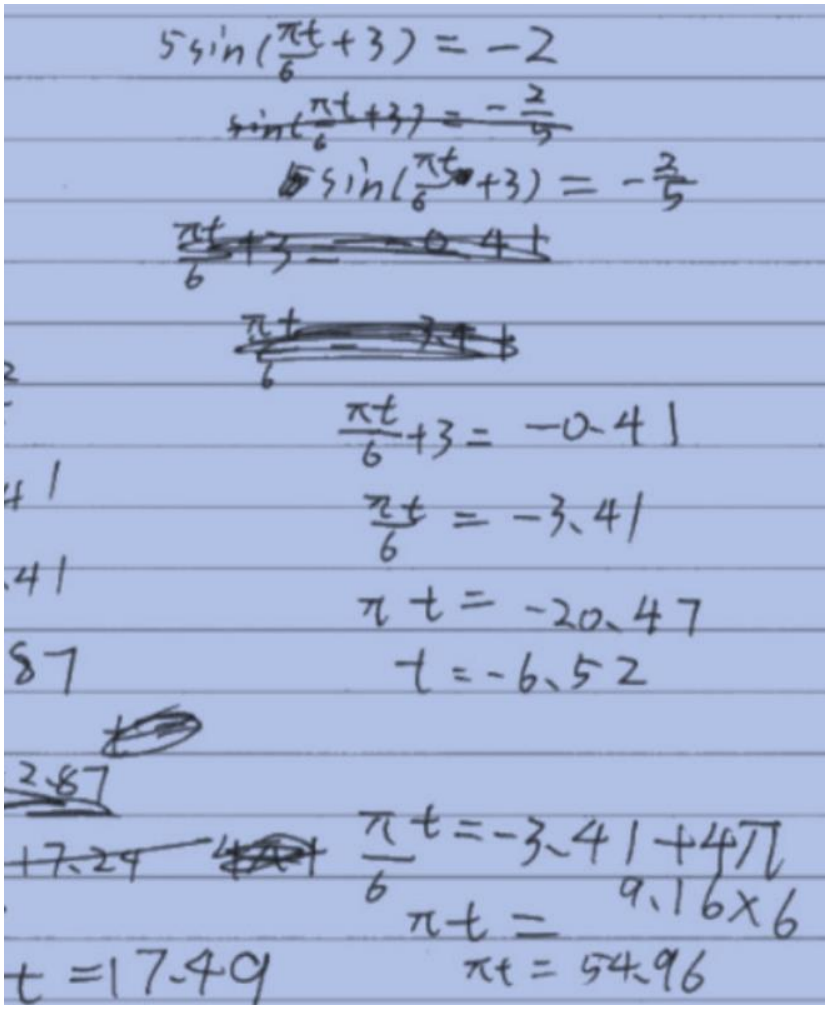
Score for any *t* value awrt 1.05/1.06, 5.48/5.49, 13.0/13.1, 17.5/17.6 following M1 A1dM1

A1: 13:04 or 1:04 pm. Condone/allow an answer of 13.03 or 1.03pm.

Condone one hour and 4 minutes after midday

Requires $\arcsin(-0.4) =$ awrt $9.84$, $t =$ awrt $13.1$ and a time of 13:03 o.e.

**Note that the steps may not occur in exactly the same way but it is equivalent work.**




dM1 scored here
Adding on $4\pi$ at this stage is equivalent work to $\frac{\pi t}{6}+3=-0.41+4\pi=\text{awrt}12.2$
ddM1 scored on lhs for 17.49

**Note that all the above steps must be seen to score full/part marks here**
Example1

Using num-solv on TI-36XPro: $6=8+5\sin\left(\frac{\pi t}{6}+3\right)\Rightarrow t=1.056$ scores 00000

Example2

Using num-solv on TI-36XPro: $6=8+5\sin\left(\frac{\pi t}{6}+3\right)\Rightarrow \sin\left(\frac{\pi t}{6}+3\right)=-\frac{2}{5}\Rightarrow t=1.056$ scores 11000

Example 3
Using 24 hours in a day:

$6=8+5\sin\left(\frac{\pi t}{6}+3\right)\Rightarrow \sin\left(\frac{\pi t}{6}+3\right)=-\frac{2}{5}\Rightarrow \frac{\pi t}{6}+3=-0.4115\Rightarrow t=-6.515+24\Rightarrow t=17.485$ scores 11000

| Question Number | Scheme | Marks |
|---|---|---|
| **6(a)** | Sets $f\left(-\frac{3}{2}\right)=0 \Rightarrow \left(9p+4q=102\right)$ | M1 |
| | Sets $f(-2)=-5 \Rightarrow \left(4p+q=43\right)$ | M1 |
| | Solves to get values for $p$ and $q$ | dM1 |
| | (i) $p=10$ * (ii) $q=3$ following two correct equations | A1*, A1 |
| | | **(5)** |
| (b) | $f'(x)=12x^2+20x+8$ | B1 |
| | Solves $f'(x)=0 \Rightarrow 4\left(3x+2\right)(x+1)=0 \Rightarrow x=-\frac{2}{3},-1$ | M1, A1 |
| | $-1<x<-\frac{2}{3}$ | A1 |
| | | **(4)** |
| | | **Total 9** |

(a)

M1: Attempts to set $f\left(-\frac{3}{2}\right)=0$ **to form an equation in *p* and *q***. Setting $f\left(\frac{3}{2}\right)=0$ is M0

Award for an attempt such as $4\left(\frac{-3}{2}\right)^3+p\left(\frac{-3}{2}\right)^2+8\left(\frac{-3}{2}\right)+q=0$ condoning slips (e.g. lack of bracketing)

Note that the partially simplified correct equation is $-\frac{27}{2}+\frac{9p}{4}-12+q=0$

You may see an attempt via division. Look for division by $\left(2x+3\right)$ leading to a remainder in *p* and *q* which should be set equal to 0

M1: Attempts to set $f(-2)=-5$ **to form an equation in *p* and *q***. Setting $f(2)=-5$ or $f(-2)=5$ is M0

Award for $4\left(-2\right)^3+p\left(-2\right)^2+8\left(-2\right)+q=-5$ condoning slips (e.g. lack of bracketing).

Note that the partially simplified correct equation is $-32+4p-16+q=-5$

You may see an attempt via division. Look for division by $\left(x+2\right)$ leading to a remainder in *p* and *q* which should be set equal to $-5$

dM1: Solves a pair of equations in both *p* and *q* resulting from setting $f\left(\pm\frac{3}{2}\right)=0$ and $f(\pm2)=\pm5$

Just look for some work (either substitution or elimination) which may or may not be correct leading to values for *p* and *q*. They know that *p* should be 10 so there will be a certain amount of fudging. Be generous here and give BOD if they show **some** correct work leading to both values Allow the solution to be done via a calculator but the solution must fit at least one of the equations if done this way.

So if both equations are correct, or only one equation is correct, writing down *p* = 10, *q* =3 would score this mark as it is a solution to both.

Examples of sufficient work

Ex 1 (Correct equations/elimination): $\frac{9}{4}p+q=\frac{51}{2}$ (1),

$4p+q=43$ (2), then (2) − (1) $\frac{7}{4}p=... \Rightarrow p=..., q=...$

Ex 2: (Incorrect first equation f (3/2) =0, substitution)

$\frac{9}{4}p+q=-\frac{51}{2},\ 4p+q=43 \Rightarrow \frac{9}{4}p+43-4p=\frac{51}{2} \Rightarrow p=..., q=...$