Question Number	Scheme	Marks
7 (a)	$\mathrm{f}(x)=x^3\sqrt{4x+7} \Rightarrow \mathrm{f}'(x)=3x^2\sqrt{4x+7}+2x^3\left(4x+7\right)^{-\frac{1}{2}}$	M1, A1
	$\Rightarrow \mathrm{f}'(x)=3x^2\sqrt{4x+7}+\dfrac{2x^3}{\sqrt{4x+7}}=\dfrac{3x^2\left(4x+7\right)+2x^3}{\sqrt{4x+7}}$	dM1
	$\Rightarrow \mathrm{f}'(x)=\dfrac{7x^2\left(2x+3\right)}{\sqrt{4x+7}}$	A1
		(4)
(b)	Substitutes $x=-\dfrac{3}{2}$ into $x^3\sqrt{4x+7} \Rightarrow y=...$	M1
	$\left(-\dfrac{3}{2},-\dfrac{27}{8}\right)$	A1
		(2)
(c)	Attempts $-4\times"-\dfrac{27}{8}"$	M1
	y „ $\dfrac{27}{2}$	A1
		(2)
(d)	$\left(2,7\right)$	M1, A1
		(2)
		Total 10

(a)

M1: Attempts the product rule to achieve $\mathrm{f}'(x)=Px^2\sqrt{4x+7}+Qx^3\left(4x+7\right)^{-\frac{1}{2}}$ where P and Q are positive constants.

Other methods are possible so look at each one carefully.

For example: $\mathrm{f}(x)=x^3\sqrt{4x+7} \Rightarrow \mathrm{f}(x)=\sqrt{4x^7+7x^6} \Rightarrow \mathrm{f}'(x)=\dfrac{1}{2}\left(4x^7+7x^6\right)^{-\frac{1}{2}}\times\left(28x^6+42x^5\right)$

The same principles for the main mark scheme can be applied

A1: $\mathrm{f}'(x)=3x^2\sqrt{4x+7}+2x^3\left(4x+7\right)^{-\frac{1}{2}}$ o.e. which may be left unsimplified

dM1: Dependent upon previous M1. It is for "correctly" producing a single fraction with a denominator of $\sqrt{4x+7}$.

Look for $\mathrm{f}'(x)=Px^2\sqrt{4x+7}+Qx^3\left(4x+7\right)^{-\frac{1}{2}} \Rightarrow \dfrac{Px^2(4x+7)+Qx^3}{\sqrt{4x+7}}$ o.e

A1: $\mathrm{f}'(x)=\dfrac{7x^2\left(2x+3\right)}{\sqrt{4x+7}}$

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It is possible to attempt this by WMA14 methods using $\left[\mathrm{f}(x)\right]^2=x^6\left(4x+7\right)=4x^7+7x^6$

Score

M1, A1: $2\mathrm{f}(x)\mathrm{f}'(x)=28x^6+42x^5$

dM1, A1: $\mathrm{f}'(x)=\dfrac{14x^5(2x+5)}{2\mathrm{f}(x)}=\dfrac{14x^5(2x+5)}{2x^3\sqrt{4x+7}}=\dfrac{7x^2(2x+5)}{\sqrt{4x+7}}$

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(b)

M1: Attempts to substitute $x = -\frac{3}{2}$ into $x^3\sqrt{4x+7}$ to find the y value of the minimum point .

This may be implied by the correct y value.

It can be attempted even if part (a) is missing or incorrect

If they ignore the given form of $f'(x)$ and use their own version, they must

- Set their $f'(x)$ which must be of the form $Px^2\sqrt{4x+7} + Qx^3(4x+7)^{-\frac{1}{2}} = 0$
- Solve $Px^2\sqrt{4x+7} + Qx^3(4x+7)^{-\frac{1}{2}} = 0$ by multiplying by $(4x+7)^{\frac{1}{2}}$ o.e. to achieve a non-zero value for x
- Substitute this non zero value for x in into $x^3\sqrt{4x+7}$ to find y

A1: $\left(-\frac{3}{2}, -\frac{27}{8}\right)$ which may be awarded separately as, for example, $x = -1.5$, $y = -3.375$

Ignore (0, 0) if also given.

(c)

M1: Attempts $\pm 4 \times "-\frac{27}{8}"$ which may be seen within an inequality.

A1: $y \text{,,} \frac{27}{2}$ which must be correctly simplified.

Allow it to be written in other correct forms such as $g \text{,,} \frac{27}{2}$, $g(x) \text{,,} \frac{27}{2}$ or $(-\infty, 13.5]$

The original function is f so $f(x) \text{,,} \frac{27}{2}$ would be M1 A0

(d)

M1: For one correct coordinate. Look for $(2, ...)$ or $(..., 7)$. Allow for either $x = 2$ or $y = 7$

If the coordinates have been built up mark the final answer.

E.g. $\left(\frac{1}{2}, \frac{3}{8}\right) \rightarrow \left(2, \frac{3}{8}\right) \rightarrow (2, 15) \rightarrow (-6, 15)$ would score M0 A0

A1: $(2, 7)$. Allow $x = 2$ and $y = 7$ ISW after a correct answer

Question Number	Scheme	Marks
8 (a)	52 b.p.m.	B1
		(1)
(b)	32 b.p.m.	B1
		(1)
(c)	$\dfrac{\mathrm{d}H}{\mathrm{d}t} = -8\,\mathrm{e}^{-0.2t} + 18\,\mathrm{e}^{-0.9t}$	M1, A1
	Sets $-8\,\mathrm{e}^{-0.2t} + 18\,\mathrm{e}^{-0.9t} = 0 \Rightarrow 4\mathrm{e}^{0.7t} = 9$	dM1
	$\Rightarrow 0.7t = \ln\dfrac{9}{4} \Rightarrow t = ...$	M1
	T = 1.158 (minutes)	A1
		(5)
(d)	$37 = 32 + 40\,\mathrm{e}^{-0.2t} - 20\,\mathrm{e}^{-0.9t} \Rightarrow \mathrm{e}^{-0.2t} = \dfrac{1+4\,\mathrm{e}^{-0.9t}}{8}$	M1
	$\Rightarrow \mathrm{e}^{0.2t} = \dfrac{8}{1+4\,\mathrm{e}^{-0.9t}} \Rightarrow t = 5\ln\left(\dfrac{8}{1+4\,\mathrm{e}^{-0.9t}}\right)$	A1*
		(2)
(e)	$t_2 = 5\ln\left(\dfrac{8}{1+4\mathrm{e}^{-0.9\times 10}}\right) = ...$	M1
	$\left(t_2\right)$ = awrt 10.3947	A1
	(M)= 10.3955	A 1
		(3)
		Total 12

(a)

B1: 52 b.p.m. Units are not required. Check for answer given in the body of the question

(b)

B1: 32 b.p.m. . Units are not required. Check for answer given in the body of the question

(c)

M1: Achieves $\dfrac{\mathrm{d}H}{\mathrm{d}t} = P\,\mathrm{e}^{-0.2t} + Q\mathrm{e}^{-0.9t}$ where P and Q are constants

A1: $\dfrac{\mathrm{d}H}{\mathrm{d}t} = -8\,\mathrm{e}^{-0.2t} + 18\,\mathrm{e}^{-0.9t}$ but allow un-simplified versions

dM1: Sets $P\,\mathrm{e}^{-0.2t} + Q\,\mathrm{e}^{-0.9t} = 0 \Rightarrow m\mathrm{e}^{0.7t} = n$ or $m\mathrm{e}^{-0.7t} = n$ where $m \times n > 0$

M1: Solves an equation of the form $m\mathrm{e}^{\pm kt} = n$ where $m \times n > 0$ using correct ln work.
It must proceed from a correct form of the derivative (so the first M1).

Look for $m\mathrm{e}^{\pm kt} = n \Rightarrow \mathrm{e}^{\pm kt} = \dfrac{n}{m} \Rightarrow \pm kt = \ln\left(\dfrac{n}{m}\right) \Rightarrow t = ...$

A1: T = awrt 1.158 minutes following the award of all previous marks. You can ignore units

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An alternative for the last three marks in part (c) are;

dM1: $P\mathrm{e}^{-0.9t} = Q\mathrm{e}^{-0.2t} \Rightarrow \ln P - 0.9t = \ln Q - 0.2t$

M1: Collects terms in t and proceeds to t =… Under this method it is dependent upon both previous M's

A1: T = awrt 1.158 minutes following the award of all previous marks. Units are not required