Question Number	Scheme	Marks
9 (a)	Substitute $t=4$ in $3\log_2(t+4)-2\log_2(t-2)\Rightarrow 3\log_2 8-2\log_2 2$	M1
	$=3\times3-2\times1=7$ ✓	A1
		(2)
(b)	One correct log law applied. E.g $3\log_2(t+4)=\log_2(t+4)^3$	M1
	Correctly removes logs $\dfrac{(t+4)^3}{(t-2)^2}=2^7$	A1
	$t^3+12t^2+48t+64=128\left(t^2-4t+4\right)\Rightarrow t^3-116t^2+560t-448=0$	A1*
		(3)
(c)	$t^3-116t^2+560t-448=(t-4)\left(t^2+.....\pm112\right)$	M1
	$t^3-116t^2+560t-448=(t-4)\left(t^2-112t+112\right)$	A1
	Solves their $t^2-112t+112$ and finds at least the value of t greater than 2	dM1
	$t=4,\ 56+12\sqrt{21}$	A1
		(4)
		Total 9

(a) Note the demand of the question.

Candidates cannot substitute $t=4$ into $t^3-116t^2+560t-448=0$ unless all the work in part (b) is done in part (a)

M1: Substitute $t=4$ in $3\log_2(t+4)-2\log_2(t-2)$ **and simplifies to achieve**

either $3\log_2 8-2\log_2 2$ or $3\log_2(4+4)-2\log_2(4-2)=9-2$

There are other possible ways including substituting $t=4$ into $\log_2\dfrac{(t+4)^3}{(t-2)^2}\rightarrow\log_2\dfrac{8^3}{2^2}$

If the equation is adapted it must be correct

A1: Correctly verifies with a minimal conclusion seen. E.g. $=3\times3-2\times1=7$ ✓

Condone sight of the calculation partially completed if deemed reasonable, E.g. $=9-2=7$ ✓

There are other possible ways including

- $3\log_2 8-2\log_2 2=9\log_2 2-2\log_2 2=7\log_2 2=7$ Hence true
- $3\log_2(t+4)-2\log_2(t-2)=\log_2\dfrac{(t+4)^3}{(t-2)^2}=\log_2\dfrac{8^3}{2^2}=\log_2 128=7$ QED

The calculation of the logs must be something that could reasonably be done in your head.

So $\log_2\dfrac{8^3}{2^2}=7$ is insufficient

(b) Work from part (a) can only count in part (b) if it used in part (b). See example

M1: One correct log law seen and applied to the given equation.

In almost all cases this will be a power law but it can be awarded for $7=\log_2 128$

A1: Removes logs and forms a correct un-simplified equation. E.g. $\dfrac{(t+4)^3}{(t-2)^2}=2^7$ o.e.

A1*: Proceeds to the given answer with sufficient intermediate work shown.

Any incorrect working (including missing brackets) within the body of their solution should be penalised.

See main scheme for a minimal acceptable solution

(c)

M1: Uses the fact that $t=4$ is a solution so $(t-4)$ must be a factor.

Score for attempting to divide or factor out $(t-4)$

For factorisation look for $t^3-116t^2+560t-448=(t-4)\left(t^2\pm...t\pm112\right)$

For division look for $t-4\overline{)t^3-116t^2+560t-448}$ $t^2\pm112t\pm...$ or $t-4\overline{)t^3-116t^2+560t-448}$ $t^2\pm120t\pm...$

A1: Correct quadratic factor $\left(t^2-112t+112\right)$

dM1: Solves their $t^2-112t+112$ and finds at least the value of *t* greater than 2

It is dependent upon the previous method. Allow use of a calculator to solve the quadratic. Allow a decimal answer here, accuracy awrt 3sf.

A1: States $t=4,\ 56+12\sqrt{21}$ and no other solutions following the award of M1 A1 dM1

……

Candidates who simply write $t^3-116t^2+560t-448=0$ followed by $t=4,\ 56\pm12\sqrt{21}$ score 0 marks.

All previous M's and A must have been scored before the final A1 mark is given.

……

Question Number	Scheme	Marks
10 (a)	$y=\dfrac{9x-x^2}{2\sqrt{x}}=\dfrac{9}{2}x^{\frac{1}{2}}-\dfrac{1}{2}x^{\frac{3}{2}} \Rightarrow \quad \dfrac{\mathrm{d}y}{\mathrm{d}x}=\dfrac{9}{4}x^{-\frac{1}{2}}-\dfrac{3}{4}x^{\frac{1}{2}}$	M1, A1
	Sets $\dfrac{9}{4}x^{-\frac{1}{2}}-\dfrac{3}{4}x^{\frac{1}{2}}=0 \Rightarrow x=\dfrac{9}{4}\times\dfrac{4}{3} \Rightarrow x=3$	dM1, A1
		(4)
(b)	$\displaystyle\int\left\{\frac{9}{2}x^{\frac{1}{2}}-\frac{1}{2}x^{\frac{3}{2}}\right\}\mathrm{d}x=3x^{\frac{3}{2}}-\frac{1}{5}x^{\frac{5}{2}}$	M1, A1
	Upper limit is 9	B1
	Area $R=\left[3x^{\frac{3}{2}}-\dfrac{1}{5}x^{\frac{5}{2}}\right]_1^9=\left(3\times27-\dfrac{1}{5}\times243\right)-\left(3\times1-\dfrac{1}{5}\times1\right)$	dM1
	$=\dfrac{148}{5}$	A1
		(5)
		Total 9

(a)

M1: Attempts to differentiate and achieves one term with the correct index. For this to be awarded

- *y* must be written as a sum of two terms with one index correct $y=ax^{\frac{1}{2}}\pm bx^{\cdots}$ or $y==ax^{\cdots}\pm bx^{\frac{3}{2}}$
- after differentiation a correct index must be achieved. Look for $\alpha x^{-\frac{1}{2}}\pm\beta x^{\cdots}$ or $\alpha x^{\cdots}\pm\beta x^{\frac{1}{2}}$
- the index cannot be achieved from incorrect working, so calculations such as $y=\left(9x-x^2\right)\dfrac{1}{2}\times\sqrt{x}=\dfrac{9}{2}x^{\frac{3}{2}}-\dfrac{1}{2}x^{\frac{5}{2}} \Rightarrow \dfrac{\mathrm{d}y}{\mathrm{d}x}=\ldots x^{\frac{1}{2}}\pm\ldots x^{\frac{3}{2}}$ would score M0

Alternatively, they may use the quotient rule. Look for $\dfrac{\mathrm{d}y}{\mathrm{d}x}=\dfrac{2\sqrt{x}\left(\alpha-\beta x\right)-\left(9x-x^2\right)\times\delta x^{-\frac{1}{2}}}{\varepsilon x}$

A1: Correct differentiation which may be left un-simplified.

Via the quotient rule this would be $\dfrac{\mathrm{d}y}{\mathrm{d}x}=\dfrac{2\sqrt{x}\left(9-2x\right)-\left(9x-x^2\right)\times x^{-\frac{1}{2}}}{4x}$ which may be left un-simplified

dM1: Solves their $\dfrac{\mathrm{d}y}{\mathrm{d}x}=0$ which must have correct indices. Index work when solving must be correct

Look for $\alpha x^{-\frac{1}{2}}\pm\beta x^{\frac{1}{2}}=0\Rightarrow\ldots x=\ldots$ with the index of *x* being 1

Alternatively squares E.g. $\alpha x^{-\frac{1}{2}}=\pm\beta x^{\frac{1}{2}} \Rightarrow \ldots x^{-1}=\ldots x^{1} \Rightarrow x^2=\ldots \Rightarrow x=\ldots$

Via the quotient rule the equation should proceed to a form $px^{\frac{1}{2}}\left(qx+r\right)=0\Rightarrow x=\ldots$

A1: Correct calculations and working leading to the $x = 3$ at *P*.

Cannot be scored from an incorrect $\dfrac{\mathrm{d}y}{\mathrm{d}x}$ so M1, A0, M1, A1 is NOT possible

Allow $\dfrac{9}{4}x^{-\frac{1}{2}}-\dfrac{3}{4}x^{\frac{1}{2}}=0\Rightarrow x=3$ without any intermediate work.