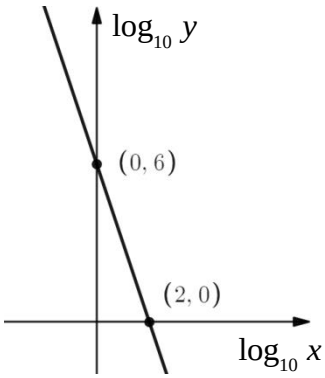
Question Number	Scheme	Marks
3 (i)	$y = \dfrac{10^6}{x^3} \Rightarrow \log_{10} y = \log_{10} 10^6 - \log_{10} x^3 \Rightarrow \log_{10} y = 6 - 3\log_{10} x$	
		B1 B1 B1 **(3)**
(ii)	States $\log_3 N = 2t + 4$ **or** $\log_3 N = \log_3 a + t\log_3 b$	B1
	$N = 3^{2t+4} = 3^{2t} \times 3^4$ **or** $\log_3 a = 4 \Rightarrow a = ...$ **or** $\log_3 b = 2 \Rightarrow b = ...$	M1
	$N = 81 \times 9^t$	A1cso **(3)** **(6 marks)**

(i) **Condone invisible brackets around coordinates provided the meaning is clear.**

Coordinates may be stated away from the graph which is fine provided a graph is drawn.
Note that they may draw a curve so B0B1B1 is possible as the marks are earned independently of each other.
Note that if they draw on Figure 2 the axis labels are incorrect so maximum score is B0B1B1

B1: For a straight line with negative gradient anywhere on a set of axes. It must intersect both axes and not stop at these points. Do not penalise if the line is not perfectly straight and do not be concerned with the steepness provided there is no intention to draw a curve or a horizontal line. Axes do not need to be labelled but if they are then the *y*-axis needs to be $\log y$ and the horizontal axis must be $\log x$ (with or without base 10 labelled)

B1: For an intercept of 6 on the $\log_{10} y$ axis for their graph. Can be labelled as just 6 instead of $(0, 6)$. The line must pass through (or start/stop at) this point. Condone *y* intercept labelled as $(6, 0)$ provided the point is on the positive *y*-axis. Do not be concerned by the axis labelling for this mark.

B1: For an intercept of 2 on the $\log_{10} x$ axis for their graph. Can be labelled as just 2 instead of $(2, 0)$. The line must pass through (or start/stop at) this point. Condone *x* intercept being labelled as $(0, 2)$ provided the point is on the positive *x*-axis. Do not be concerned by the axis labelling for this mark.

(ii) **Note that $N = 81 \times 9^t$ with no working is 0 marks**

May work in terms of *x* instead of *t* which is fine, but the final answer must be in terms of *t*

A misread writing a different base to 3 (including 10) can score a maximum B0M1A0.

B1: For a correct equation $\log_3 N = 2t + 4$ which may be left unsimplified or states $\log_3 N = \log_3 a + t \log_3 b$

Condone lack of base 3 written but base 10 is B0. May be implied by further work which is not the final answer.

If they write down an incorrect equation e.g. $\log_3 N = -2t + 4$ as well as $\log_3 N = \log_3 a + t \log_3 b$ then allow this mark to be scored.

M1: For using the laws of logs correctly and moving from $\log_3 N = at + b$ to $N = 3^{at} \times 3^b$

If they write $3^{2t} + 3^4$ then M0A0 but if it is ambiguous between a + and $\times$ give the benefit of the doubt.

This may involve using their $\log_3 N = at + b$ for two different values for *t* to find *N* using logs correctly. They then form two simultaneous equations using $N = ab^t$ and proceed to find a value for *a* or *b*.

e.g. $t = 1 \Rightarrow \log_3 N = 6 \Rightarrow N = 729,\ t = 2 \Rightarrow \log_3 N = 8 \Rightarrow N = 6561$

$$\Rightarrow ab = 729,\ ab^2 = 6561 \Rightarrow b = \frac{6561}{729} \text{ or } a = 81$$

e.g. $(0, 81),\ (-2, 1) \Rightarrow 81 = ab^0,\ 1 = ab^{-2} \Rightarrow a = 81$ or $b = 9$

Alternatively, forms an equation in *a* or *b* and proceeds to find a value for *a* or *b* using logs correctly.

(may be implied by their values for *a* or *b* **provided no incorrect log work is seen**)

If they misread and write a different base this mark can be scored for working correctly in that base.

e.g. $\log_{10} a = 4 \Rightarrow a = 10^4$ o.e. or e.g. $N = 10^4 \times 10^{2t}$

A1: $N = 81 \times 9^t$ cso **Just stating the values of *a* and *b* does not score this mark. Must be in terms of *t***
We must see

- $\log_3 N = 2t + 4$ or $N = 3^{2t+4}$ or $N = 3^{2t} \times 3^4$ before proceeding to the answer with no incorrect log work seen
- $\log_3 N = \log_3 a + t \log_3 b$ **or** both $\log_3 a = 4 \Rightarrow a = 3^4$ o.e. **and** $\log_3 b = 2 \Rightarrow b = 3^2$ o.e. before proceeding to $N = 81 \times 9^t$

Note that e.g. $N = 3^{2t+4} = 3^{2t} + 3^4 \Rightarrow N = 81 \times 9^t$ is B1M0A0 (incorrect log work – the values of 81 and 9 cannot imply the method mark as we see incorrect log work)

Question Number	Scheme	Marks
	$f(x) = 8\sin x\cos x + 4\cos^2 x - 3$	
4(a)	States or uses $\sin 2x = 2\sin x\cos x$ or $\cos 2x = \pm 2\cos^2 x \pm 1$	M1
	Uses $\sin 2x = 2\sin x\cos x$ and $\cos 2x = \pm 2\cos^2 x \pm 1$ in f (x)	dM1
	$\left(f(x) =\right) 8\sin x\cos x + 4\cos^2 x - 3 = 4\sin 2x + 2\cos 2x - 1$	A1
		(3)
(b)	$R^2 = a^2 + b^2 \Rightarrow R = \sqrt{20}$ or $2\sqrt{5}$	B1ft
	$\tan\alpha = \frac{b}{a} \Rightarrow \alpha = ...$ $\left(= \text{"awrt } 0.464\text{"}\right)$	M1
	$\left(f(x) =\right)\ 2\sqrt{5}\sin\left(2x + 0.464\right) - 1$	A1
		(3)
(c)	(i) Maximum value = $\text{"}2\sqrt{5} - 1\text{"}$	B1 ft
	(ii) Solves $2x + \alpha = \frac{5\pi}{2} \Rightarrow x = ...$	M1
	$\left(x =\right)$ awrt 3.69 (or $\left(x =\right)$ awrt 3.70)	A1
		(3)
		(9 marks)

(a) For the method marks condone working in mixed variables provided the intention is clear

M1: **Either** states one of the correct identities $\sin 2x = 2\sin x\cos x$ or $\cos 2x = 2\cos^2 x - 1$

or uses $\sin 2x = 2\sin x\cos x$ or $\cos 2x = \pm 2\cos^2 x \pm 1$ (may be implied by use of e.g. $\cos^2 x = \pm 1 \pm \sin^2 x$ and $\cos 2x = \pm 1 \pm 2\sin^2 x$ or $\cos 2x = \pm\cos^2 x \pm \sin^2 x$)

Can be implied by **either of**

- $a = 4$
- $b = \pm 2$ **and** $c = -5$ or -1

dM1: **Uses** $\sin 2x = 2\sin x\cos x$ and $\cos 2x = \pm 2\cos^2 x \pm 1$ (which may be implied as above for the first method mark) in f (x) to produce an expression of the required form $a\sin 2x + b\cos 2x + c$ Condone slips when substituting in.

Can be implied by $a = 4$ **and** $b = \pm 2$ **and** $c = -5$ or -1

A1: $4\sin 2x + 2\cos 2x - 1$ Correct answer scores all three marks. Must be in terms of x.

(b) **Full marks can only be scored provided correct values for *a*, *b* and *c* are found in (a).**

B1ft: Finds the exact value of R using $R^2 = a^2 + b^2$ (or may use trigonometry using their value for α)

Can be implied by a correct exact value.

Follow through on their a or b but the correct values should give $R = \sqrt{20}$ or $2\sqrt{5}$