Question Number	Scheme	Notes	Marks
5(a)	$1+\frac{2}{2r+5}=\frac{2r+5+2}{2r+5}=\frac{2r+7}{2r+5}$	Obtains $\frac{2r+7}{2r+5}$	**B1**
			(1)
(b)	$\sum_{r=1}^{n}\log_3\left(1+\frac{2}{2r+5}\right)=\sum_{r=1}^{n}\log_3\left(\frac{2r+7}{2r+5}\right)=\sum_{r=1}^{n}\left(\log_3(2r+7)-\log_3(2r+5)\right)$ $r=1 \quad \cancel{\log_3 9\,(=2)} \quad - \quad \log_3 7$ $r=2 \quad \cancel{\log_3 11} \quad - \quad \cancel{\log_3 9\,(=2)}$ ... $r=n \quad \log_3(2n+7) \quad - \quad \cancel{\log_3(2n+5)}$		**M1**
	$\sum_{r=1}^{n}\log_3\left(1+\frac{2}{2r+5}\right)=\log_3(2n+7)-\log_3 7=\log_3\left(\frac{2n+7}{7}\right)$	Correct expression in correct form	**M1** **A1**
			(3)
Alt (b)	$\sum_{r=1}^{n}\log_3\left(\frac{2r+7}{2r+5}\right)=\log_3\frac{9}{7}+\log_3\frac{11}{9}+...+\log_3\frac{2n+7}{2n+5}$ $=\log_3\left(\frac{\cancel{9}}{7}\times\frac{\cancel{11}}{\cancel{9}}\times...\frac{2n+7}{\cancel{2n+5}}\right)$	Combines sum of log's to show cancelling fractions or implied cancelling.	**M1**
	$=\log_3\left(\frac{2n+7}{7}\right)$	Cancels their fractions to achieve correct form, A1 for correct answer.	**M1** **A1**
			(3)
(c)	$\sum_{r=n+2}^{10n}\log_3\left(1+\frac{2}{2r+5}\right)=\log_3\left(\frac{2(10n)+7}{7}\right)-\log_3\left(\frac{2(n+1)+7}{7}\right)$	Forms g(10n) – g(n + a) where a = 1, 2	**M1**
	$\Rightarrow\frac{20n+7}{2n+9}=3^2$	Correct removal of logs from their equation, from an attempt at difference of sums	**M1**
	$20n+7=18n+81$ $2n=74$ $n=37$	**d**M1: Solves an equation of the correct form. Requires previous method mark A1: n = 37 only	**dM1** **A1**
			(4)
			Total 8

Additional Notes

(a)

B1: Correct answer.

(b)

M1: For a valid attempt at the method of differences evidenced by at least two rows to show one cancelling pair of terms, or by correct extraction for the non-cancelling terms with clear indication of the cancelling (e.g. by extraction of the terms if no crossing out seen).

M1: Extracts their non-cancelling terms for their summation and combines the terms to a single log term.

A1: Correct expression in form required.

Note M0M1A1 is possible if the correct answers is attained by implication with the method of differences not clearly being shown.

Alt Method:

M1: Combines the log terms in the summations to a single log expression with cancelling fractions shown.
M1: Cancels the common terms in their expression to simplify to the required form.
A1: Correct expression in form required.

Note the combination of logs is not always being clearly shown in this method. Answers such as

$r = 1 \quad \log_3\left(\frac{\cancel{9}}{7}\right)$

$r = 2 \quad \log_3\left(\frac{\cancel{11}}{\cancel{9}}\right)$

$\vdots$

$r = n \quad \log_3\left(\frac{2n+7}{\cancel{2n+5}}\right) \quad \Rightarrow \log_3\left(\frac{2n+7}{7}\right)$

Can score M0M1A1

(c)

M1: Correct attempt at finding the sum from $n + 2$ to $10n$. Accept $g(10n) – g(n + a)$ where $a = 1$ or 2 for a valid attempt at the method, with their answer to (b), where $g(n)$ is the answer to (b).

Allow for answers which "use" part (b) to deduce the new first and last terms/new non-cancelling terms and proceed to form the correct expression.

M1: Correct method to eliminate logs and achieve an equation in n having made some attempt at a difference in summations to evaluate the sum. (Must be 3^2 and not $2^{3.}$) Note: solutions via calculator without showing removal of logs will score M0dM0A0.

dM1: Depends on previous M. Solves the resulting equation in n

A1: Correct