Question Number	Scheme	Marks
8 (i)	(a) $S_n = a + (a+d) + ... + (a+(n-1)d)$ (1) $S_n = (a+(n-1)d) + ... (a+d) + a$ (2) (1) + (2) $2S_n = (2a+(n-1)d) + (2a+(n-1)d) ..... + (2a+(n-1)d)$ $2S_n = n(2a+(n-1)d) \Rightarrow S_n = \frac{n}{2}(2a+(n-1)d)$ *	B1 M1 A1*
		(3)
	(b) States or uses two of $a = 900$, $d = -8$ and $n = 51$ Or alternatively states or uses two of $a = 500$, $d = 8$ and $n = 51$ Complete method E.g $n = \frac{900-500}{8} + 1$ and $S = \frac{51}{2}\{2\times 900 + 50 \times -8\}$ 35700	B1 M1 A1
		(3)
(ii)	(a) $\frac{11-k}{k-2} = \frac{k-2}{k+4}$ $44 - k^2 + 7k = k^2 - 4k + 4$ $2k^2 - 11k - 40 = 0$ *	M1 dM1 A1*
		(3)
	(b) $2k^2 - 11k - 40 = 0 \Rightarrow k = \left(-\frac{5}{2}\right), 8$ Uses either k value and attempts to find both a and r. E.g. with $k = 8 \Rightarrow a = 8+4, r = \frac{8-2}{8+4}$ Uses $S_\infty = \frac{a}{1-r} = \frac{12}{1-\frac{1}{2}} = 24$	B1 M1 dM1, A1
		(4)
		Total 13

(i)(a)

B1: A correct expression for S_n (but allow S) with a minimum of three terms including the first and last terms **WITH** no incorrect terms. Note that an incorrect order does not imply an incorrect term
So, you may see $S_n = a + (a+d) + ... + (a+(n-1)d) + (a+(n-2)d)$ which is B1

M1: A correct method to find an expression for S_n in terms of a, n and d. Look for

- a sum with correct first and last terms
- the sum reversed (with at least first and last terms) and an attempt made to add the two series

This mark is usually scored when the candidate works with the sum $S_n = a + ... + a + (n-1)d$
Condone attempts with incorrect terms. (See below).

E.g. $S_n = a + (a+d) + ... + a + nd + (a+(n-1)d)$
$S_n = (a+(n-1)d) + a + nd + ... (a+d) + a$
$2S_n = 2a + (n-1)d ..... 2a + (n-1)d$

A1*: Correct proof that has previous lines scoring both B1 and M1 as well as a line equivalent to $2S_n = n(2a+(n-1)d)$ or equivalent before the given answer.

You may see alternative proofs which define $l = a + (n-1)d$.
This is acceptable and the same marking scheme can be applied.

A minimal acceptable proof would be

$$S_n = a + (a+d) + ... + (a+(n-1)d)$$
$$\underline{S_n = (a+(n-1)d) + ... + (a+d) + a}$$
$$2S_n = n\{2a+(n-1)d\}$$
$$S_n = \frac{n}{2}\{2a+(n-1)d\}$$

(i) (b)

B1: States or uses at least two correct values of (i) the first term (ii) the common difference (iii) the number of terms.

Accept two of $a = 900$, $d = -8$ and $n = 51$ but it may be implied by embedded values within a formula.

Alternatively allow the sum to be reversed so $a = 500$, $d = 8$ and $n = 51$

M1: Full method of finding $900 + 892 + 884 + ... + 500$

This must include both

- an attempt to find the value of n. E.g. $500 = 900 + (n-1) \times -8 \Rightarrow n = ...$ but condone $n = \frac{900-500}{8}$ which is implied by $n = 50$
- with an attempt at using the correct formula.

  Either $S_n = \frac{n}{2}(2a+(n-1)d)$ with $a = 900$ or 500 **and** $d = \pm 8$ **and** $n = 50$ or 51

  or $S_n = \frac{n}{2}(a+l)$ with $a + l = 900 + 500$ **and** $n = 50$ or 51

A1: 35700

(ii) **The two parts in (ii) may be marked as a single question**

(a)

M1: Correct attempt to use the fact that these are consecutive terms in a GP to set up an equation in k.

Look for $\frac{11-k}{k-2} = \frac{k-2}{k+4}$ or $11-k = \left(\frac{k-2}{k+4}\right) \times (k-2)$ or equivalent condoning slips

dM1: Cross multiplies, expands and starts to collect terms. It is dependent upon the previous M

See main scheme which has terms collected on either side of the = sign.

A1*: Correct working with sufficient intermediate work to show the given answer of $2k^2 - 11k - 40 = 0$.

An intermediate line of $44 - k^2 + 7k = k^2 - 4k + 4$ o.e. is sufficient. The $= 0$ must be present

(ii)(b)

B1: Solves $2k^2 - 11k - 40 = 0$ and achieves at least 8. The other value if found can be ignored

M1: Uses either of their k values and attempts to find both a and r. May be embedded within a formula.

The value of a must be found using $k + 4$ and r must be attempted using the ratio $\frac{11-k}{k-2}$ or $\frac{k-2}{k+4}$

FYI when with $k = -\frac{5}{2} \Rightarrow a = -\frac{5}{2} + 4 = \left(\frac{3}{2}\right)$, $r = \frac{-\frac{5}{2}-2}{-\frac{5}{2}+4} = (-3)$

dM1: Uses $S_\infty = \frac{a}{1-r}$ with their $|r| < 1$. It is dependent on the previous M but also a value of r where $|r| < 1$

A1: 24 only. If two values are found it must be made clear that only this one is acceptable.

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