Question Number	Scheme	Marks
8 (i)	$S_n = a + ar + ar^2 + ...ar^{n-1}$	B1
	$S_n = a + ar + ar^2 + ...ar^{n-1}$ **and** $rS = ar + ar^2 + ar^3 + ...ar^n$	
	Finds S_n and rS_n and subtracts. E.g. $S - rS = ...$	M1
	Completes proof $\Rightarrow S_n(1-r) = a(1-r^n) \Rightarrow S_n = \dfrac{a(1-r^n)}{(1-r)}$ *	A1*
		(3)
(ii) (a)	Attempts $U = 150 \times 0.92^n$ with $n = 5 \text{ or } 6$	M1
	$\Rightarrow (U_6) = 150 \times (0.92)^6 = 90.95$ (≈ 91 litres) *	A1*
		(2)
(b)	Attempts $S_n = \dfrac{a(1-r^n)}{(1-r)}$ with $n = 39/40/41$ $a = 150/138$ and $r = 0.92$	M1
	$S = \dfrac{138(1-0.92^{40})}{(1-0.92)}$, $S = 150 \times \dfrac{0.92(1-0.92^{40})}{(1-0.92)}$ OR $S = \dfrac{150(1-0.92^{41})}{(1-0.92)} - 150$	A1
	1664 litres	A1
		(3)
		(8 marks)

Do not be too concerned with labelling here. It should be obvious which part of the question candidates are attempting to answer

(i) Condone $S \leftrightarrow S_n$ throughout.

A proof via the infinite sum formula gains no credit unless you see a correct expression for S_n.

B1: Scored for a correct expression for S_n. For example, $S_n = a + ar + ar^2 + ...ar^{n-1}$

including the "S_n" with a minimum of 3 terms and must include the first and the nth term.

$S_n = a + ar + ...ar^{n-1}$ would be acceptable but $S_n = a + ...ar^{n-1}$ is not.

It cannot be scored if some terms are incorrect $S_n = a + ... + \underline{\underline{ar^n}} + ar^{n-1}$

Or they are not in the correct order $S_n = a + ...ar^{n-1} + ar^{n-2}$

M1: States $S_n = a + ar + ar^2 + ...ar^{n-1}$ (minimum of 3 **correct** terms including **first** and **last** terms)

and $rS_n = ar + ar^2 + ...ar^n$ (minimum of 3 correct terms including first and last terms)

followed by an attempt to subtract either way around

A1*: Fully correct proof. Look for the following 3 lines (or their equivalents) following B1, M1

- $S_n - rS_n = a - ar^n$
- $S_n(1-r) = a(1-r^n)$
- $S_n = \dfrac{a(1-r^n)}{(1-r)}$ (Note that this is a given answer)

Special case: Candidates who do not have the '+' signs in their work

Example

$S_n : a \quad ar \quad ar^2 \quad ..... \quad ar^{n-1}$

$rS_n : ar \quad ar^2 \quad ar^3 \quad ..... \quad ar^n$

$rS_n - S_n = ar^n - a$

$(r-1)S_n = a(r^n - 1) \Rightarrow S_n = \dfrac{a(r^n-1)}{(r-1)} \Rightarrow S_n = \dfrac{a(1-r^n)}{(1-r)}$

Scores SC B0, M1, A1

(Note that this candidate subtracts the other way around, but the given answer must be produced and follow correct working)

(ii) (a)

M1: Attempts $U_n = 150 \times 0.92^n$ with $n = 5 \text{ or } 6$.

You may see variations on this such as $150 \times (92\%)^5$

Allow step by step solutions such as

$150 \overset{\times 0.92}{\rightarrow} 138 \overset{\times 0.92}{\rightarrow} 126.96 \overset{\times 0.92}{\rightarrow} 116.8032 \overset{\times 0.92}{\rightarrow} 107.458944 \overset{\times 0.92}{\rightarrow} 98.86222848 \overset{\times 0.92}{\rightarrow} 90.9532502$

(with accuracy at least 1dp for the M1)

A1*: Awrt 90.95 but accept the truncated value 90.9. You should expect to see an answer that isn't exactly 91

ISW after sight of a correct answer

Note that candidates who just write $150 \times 0.92^6 = 91$ then award M1, A0 as this is incorrect

If attempted via step by step solutions (listing) then intermediate answers must be correct to 2dp rounded or truncated.

(b)

M1: Attempts $S_n = \dfrac{a(1-r^n)}{(1-r)}$ with $n = 39/40/41$, $a = 150/138$ and $r = 0.92$ o.e. such as 92%

A1: A correct expression. You may see variations of the following

$S = \dfrac{138(1-0.92^{40})}{(1-0.92)}$, $S = 150 \times \dfrac{92\%(1-92\%^{40})}{(1-92\%)}$ OR $S = \dfrac{150(1-0.92^{41})}{(1-0.92)} - 150$

A1: cao 1664 litres

Question Number	Scheme	Marks
9 (i)	$2\log_3(4x+5)-\log_3(x+3)=2 \Rightarrow \log_3\dfrac{(4x+5)^2}{(x+3)}=2$	M1, M1
	$\Rightarrow \dfrac{(4x+5)^2}{(x+3)}=9$	A1
	$\Rightarrow 16x^2+31x-2=0$	
	$(16x-1)(x+2)=0 \Rightarrow x=\dfrac{1}{16}$ only	dM1, A1
		(5)
(ii) (a)	States that $\log a+\log b=\log(ab)$ or else uses rule and proceeds from given equation $\log a+\log b=\log(a+b)$ to $\log ab=\log(a+b)$	B1
	Deduces $ab=a+b \Rightarrow ab-a=b \Rightarrow a(b-1)=b \Rightarrow a=\dfrac{b}{b-1}$ *	M1, A1*
(b)	States either $b>1$ or $b\neq 1$ as *a* would not be defined	B1
	$b>1$ as logs only exist for positive numbers	B1
		(5)
		(10 marks)

(i) **We are now scoring this question M1, M1, A1, dM1, A1**

M1: Usually scored for the power law of logs $2\log_3(4x+5) \rightarrow \log_3(4x+5)^2$ (allow without the base 3)

But may be awarded for writing 2 as $\log_3 9$

M1: For combining two terms of the original equation.

E.g $\log_3\dfrac{(4x+5)^2}{(x+3)}=2$ (allow without the base 3) or $2\log_3(4x+5)=\log_3 9(x+3)$

A1: A correct equation not involving logs. E.g. $\dfrac{(4x+5)^2}{(x+3)}=9$ or $(4x+5)^2=9(x+3)$

dM1: Requires all of the following

- A starting equation of the form (or equivalent to the form) $\dfrac{(4x+5)^2}{(x+3)}=k, \quad k>0$
- An intermediate equation that is a 3TQ
- A correct attempt to solve the 3TQ by any means condoning the use of a calculator here.

It is dependent upon scoring at least one of the previous M marks

A1: CSO $\dfrac{1}{16}$ oe only. The decimal equivalent is 0.0625
