Question Number	Scheme	Notes	Marks
8(a)	$u_{20} = 100 + 19(-2) = 62$*	Correct method shown	B1*
			(1)
(b)	$S_{20} = \frac{1}{2}(20)\{2\times 100 + 19(-2)\} = \ldots$ **or** $S_{20} = \frac{1}{2}(20)\{100 + 62\} = \ldots$	Applies a correct AP sum formula with $n = 20$, $a = 100$ and $d = -2$ **or** $n = 20$, $a = 100$ and $l = 62$	M1
	$= 1620$ (mm)	Correct value	A1
			(2)
(c)	$62 \times r^2 = 60 \Rightarrow r^2 = \ldots$	Correct strategy to find r	M1
	$r^2 = \frac{60}{62} \Rightarrow r = \sqrt{\frac{60}{62}}$ = 0.983738...	r = awrt 0.984	A1
			(2)
(d)	Total distance from GS hits = $\frac{62 \times 0.983\ldots(1 - 0.983\ldots^n)}{1 - 0.983\ldots}$		M1
	$1620 + \frac{62 \times 0.983\ldots(1 - 0.983\ldots^n)}{1 - 0.983\ldots} > 3000$	Correct equation set up with their r and suitable a	M1
	$0.983\ldots^n < 0.63207\ldots \Rightarrow n = \frac{\log(0.63207\ldots)}{\log(0.983\ldots)}$	Fully correct processing to find n from an equation of suitable form,	M1
	$n = 27.98\ldots \Rightarrow N = 20 + 28 = 48$	N = 48 only	A1cso
			(4)
	(d) Alternative taking 20th hit as first term of GP		
	Total distance from GS hits = $\frac{62(1 - 0.983\ldots^n)}{1 - 0.983\ldots}$		M1
	$1620 - 62 + \frac{62(1 - 0.983\ldots^n)}{1 - 0.983\ldots} > 3000$	Correct equation set up with their r and suitable a	M1
	$0.983\ldots^n < 0.62179\ldots \Rightarrow n = \frac{\log(0.62179\ldots)}{\log(0.983\ldots)}$	Fully correct processing to find n from an equation of suitable form,	M1
	$n = 28.98\ldots \Rightarrow N = 19 + 29 = 48$	N = 48 only	A1cso
			Total 9

Notes

(a)

B1*: Correct method shown, identifies the common difference and attempts the 20th term. Accept as minimum seeing $100 + 19(-2) = 62$.

Alternatively, allow for setting up an equation $62 = 100 + (n-1)(-2)$ and solving to find n = 20

If listing, there must be the correct 20 terms with final term 62.

(b)

M1: Applies a correct AP sum formula with n = 20, a = 100 and d = –2 or with n = 20, a =100 and l = 62. Alternatively, by listing look for 20 terms listed with attempt to sum, or implied by answer.

A1: Correct value, units not needed.

(c)

M1: Correct strategy, attempts to set up and solve the equation $62\times r^2=60$

A1: r = awrt 0.984. Accept the exact answer $\sqrt{\frac{30}{31}}$ (simplified to this)

(d)

This is now being marked as MMMA (on ePen it isMMAA).

M1: Applies a correct GS summation with their r, a = 62 or $62\times \text{their}\, r$ and n or $n-1$ or $n-19$ or $n-20$ as part of their solution in (d). Special case, allow with a =100 for this mark if they have used this in part (c) as a misunderstanding of the question.

M1: States or uses $1620+\frac{62\times 0.983...\left(1-0.983...^{n}\right)}{1-0.983...}>3000$ with their 1620 from part (b) and their r with n or $n-1$ or $n-19$ or $n-20$. Allow " > ", " = ", " < " etc. but the starting term of the GS for the combination of series must be correct.

Alternatively States or uses $1620-62+\frac{62\left(1-0.983...^{n}\right)}{1-0.983...}>3000$ with their 1620 from part (b) and their r with n or $n-1$ or $n-19$ or $n-20$. Allow " > ", " = ", " < " etc. but the starting term of the GS for the combination of series must be correct.

M1: Correct processing to solve for n in their equation which must be an attempt at combining 3000, their (b) and the sum of a GS with their r and a = 62 or $62\times \text{their}\, r$ and n or $n-1$ or $n-19$ or $n-20$. Look for reaching $(\text{their}\, r)^n=...$ before applying logs appropriately to proceed to n =... (Note n = 27.98 or 28.98 are possible correct values at this stage.)

Allow for any of " > ", " = ", " < " used in the equations.

A1cso: For N = 48 only and must have come from a correct equation (although allow for any of " > ", " = ", " < ") – all three M's must have been earned. Look for the correct values of n as a clue. If using power and $n-19$ or $n-20$ they may get directly to the answer.

Note: It is possible to get the correct answer from incorrect methods and you may see M1M0M1A0 often. Make sure they are working from a correct equation. The values 27.98 and 28.98 may help (if full accuracy is kept). A value between 27.2 and 27.8 (depending on degree of rounding used) before adding 20 likely implies a mismatch between starting term of GS and ending of AS so check carefully if the second M was earned.

Question Number	Scheme	Notes	Marks
9(a)	$mx = x - x^2 \Rightarrow m = 1 - x \Rightarrow x = ...$ Or $y = \frac{y}{m} - \frac{y^2}{m^2} \Rightarrow m^2 = m - y \Rightarrow y = ...$	Attempts to eliminate either *x* or *y* and factors out or cancels *x*/*y* to get a linear equation and solve.	M1
	$x = 1 - m$ **and** $y = m(1-m)$	Both correct	A1
			(2)
(b)	$\int x - x^2 \left(-mx\right) \mathrm{d}x = \frac{x^2}{2} - \frac{x^3}{3}\left(-m\frac{x^2}{2}\right)$	$x^n \to x^{n+1}$ in at least one term	M1
	$\text{Area of } R_1 = \int_0^{"1-m"} \left\{x - x^2\left(-mx\right)\right\} \mathrm{d}x$ $= \frac{(1-m)^2}{2} - \frac{(1-m)^3}{3}\left(-m\frac{(1-m)^2}{2}\right) - 0$	Uses the limits "1 – *m*" and 0 in their integrated expression and subtracts (condone the omission of the "– 0")	M1
		Correct expression in *m* with/without the area under line subtracted.	A1
	$\text{Area of } R_1 = \int_0^{"1-m"} \left\{x - x^2 - mx\right\} \mathrm{d}x = \frac{(1-m)^2}{2}(1-m) - \frac{(1-m)^3}{3}(-0)$ Correct strategy for the area (may be scored for finding separate areas and subtracting)		dM1
	$= \frac{(1-m)^3}{6}$ *	Correct expression	A1*
			(5)
(c)	$\text{Area of } \left(R_1 + R_2\right) = \int_0^1 \left(x - x^2\right) \mathrm{d}x = \left[\frac{x^2}{2} - \frac{x^3}{3}\right]_0^1 = ...$ $\left(= \frac{1}{6}\right)$	Correct method for finding the area of $R_1 + R_2$ Alternatively, a correct method for finding the area of R_2	M1
	Alt: $\text{Area of } R_2 = \int_{1-m}^1 \left(x - x^2\right) \mathrm{d}x + \frac{1}{2}("1-m") \times m(1-m)$ $= \left[\frac{x^2}{2} - \frac{x^3}{3}\right]_{1-m}^1 + \frac{1}{2}m(1-m)^2 = ...\left(= \frac{1}{6} - \frac{(1-m)^2}{2} + \frac{(1-m)^3}{3} + \frac{1}{2}m(1-m)^2\right)$		
	$R_1 = R_2 \Rightarrow \frac{(1-m)^3}{6} = \frac{1}{12} \Rightarrow m = ...$	Sets up a correct equation using the answer to part (b) and solves for *m*	dM1
	Alt: $\frac{(1-m)^3}{6} = \frac{1}{6} - \frac{(1-m)^2}{2} + \frac{(1-m)^3}{3} + \frac{1}{2}m(1-m)^2 \Rightarrow m = ...$		
	$m = 1 - \frac{1}{\sqrt[3]{2}}$	Correct exact value in any form	A1
			(3)
			Total 10

Notes

(a)

M1: Attempts to eliminate either *x* or *y* and factors our or cancels *x*/*y* to get a linear equation and solves the resulting equation. May be implied by one correct coordinate of the two.