Question Number	Scheme	Marks
7(a)	$(u_{100}=)20+99(0.5)=(£)69.50*$	B1*
		(1)
(b)	$S_{300}=\frac{1}{2}(300)\{2\times 20+299(0.5)\}=...$ **or** $S_{300}=\frac{1}{2}(300)\{20+169.50\}=...$	M1
	$=(£)28425$	A1
		(2)
(c)	$20\times r^{299}=250\Rightarrow r=\sqrt[299]{\frac{250}{20}}\,(=1.008483032...)$	M1
	$S_{300}=\frac{20(1-r^{300})}{1-r}=(27362.948...)$ $28425-27362.948...$	M1
	(£)1060	A1
		(3)
		Total 6

(a)

B1*: Correct method shown e.g. $20+99(0.5)=69.50$ is sufficient.

Note that the £ symbol is not required but $20+99(0.5)=69.5$ scores B0

Condone attempts to work backwards e.g.

$69.5=20+(n-1)\times 0.5\Rightarrow 49.5=(n-1)\times 0.5\Rightarrow n=100$ hence true

Note that 69.5 can be used in this case but a (minimal) conclusion is required.

(b)

M1: Attempts $\frac{1}{2}n(2\times a+(n-1)d)$ with n = 300, a = 20 and d = 0.5

or e.g. $\frac{1}{2}n(a+l)$ with n = 300, a = 20 and l = 169.5(0) (or an attempt at $20+299\times 0.5$)

A1: Correct value. The £ symbol is not required.

(c)

M1: Correct strategy to find *r* e.g. $\sqrt[299]{\frac{250}{20}}$. Award for e.g. $(r=)\sqrt[299]{\frac{250}{20}}$ or e.g. $(r=)\left(\frac{250}{20}\right)^{\frac{1}{299}}$. May be implied by awrt 1.01 if no incorrect work is seen e.g. clear use of $\sqrt[300]{\frac{250}{20}}$ which gives 1.008454636… is M0

May be done via logs e.g. $r=10^{\frac{1}{299}\log 12.5}$

M1: Uses their *r* with a correct GP sum formula with $a = 20$ and $n = 300$ and subtracts from the answer to part (b) either way round.
Depends on having attempted the **sum** of an **AP** in (b).
May be implied by their working/value.

Note this has been seen more than once for the GP sum following $\sqrt[299]{\frac{250}{20}}$:

$$S_{300}=\frac{20(1-12.5)}{1-1.008483032}$$

and scores M0 as it suggests $S_n=\frac{a\left(1-r^{n-1}\right)}{1-r}$ has been used.

A1: Cao **not awrt** with or without the "£" symbol.

Note that the accuracy being used for "*r*" varies considerably.

Some rounded values for reference are:

r	S_{300}	|Correct (b) − S_{300} |
1.01	37576.93252…	9151.932524…
1.008	24796.03972…	3628.960276…
1.0085	27458.42195…	966.5780531…
1.00848	27345.9295…	1079.070499…

Question Number	Scheme	Marks
8(a)	$x^2+3=13-\dfrac{9}{x^2}\Rightarrow x^4+3x^2=13x^2-9$ $\Rightarrow x^4-10x^2+9=0$	M1A1
	$x^4-10x^2+9=0\Rightarrow\left(x^2-1\right)\left(x^2-9\right)=0\Rightarrow x^2=...$ $\Rightarrow x=...$	M1
	$x=1,\ \ x=3$	A1
		(4)

(a) **Note we are now marking part (a) as M1A1M1A1 not M1M1A1A1**

M1: Equates the 2 curves and multiplies through by x^2 to obtain a quadratic equation in x^2

A1(**M1 on EPEN**): Correct 3TQ in x^2 with terms collected and all on one side.
Note that the "= 0" may be implied by their attempt to solve.

M1(**A1 on EPEN**): Solves a 3TQ in x^2 by a suitable method e.g. factorising, completing the square or quadratic formula **and takes the square root** to obtain at least one value for x. They may use a calculator, **but** the solution must be via x^2.
E.g. $x^4-10x^2+9=0\Rightarrow x^2=1,\ 9\Rightarrow x=1,\ 3$ is acceptable for this mark as is
$x^4-10x^2+9=0\Rightarrow\left(x^2-1\right)\left(x^2-9\right)=0\Rightarrow x=1,\ 3$
They cannot go from e.g. $x^4-10x^2+9=0$ to $x=1,\ 3$
Note $x^4-10x^2+9=0\Rightarrow\left(x-1\right)\left(x+1\right)\left(x-3\right)\left(x+3\right)=0\Rightarrow x=1,\ 3$ scores M0

A1: Both correct and no other values. Condone any confusion with which is P and which is Q and condone e.g. $P = 1$, $Q = 3$

Examples:

$$x^2+3=13-\frac{9}{x^2}\Rightarrow x^4+3x^2=13x^2-9$$
$$\Rightarrow x^4-10x^2+9=0\Rightarrow x=1,\ 3$$
Scores M1A1M0A0

$$x^2+3=13-\frac{9}{x^2}\Rightarrow x^4+3x^2=13x^2-9$$
$$\Rightarrow x^4-10x^2+9=0\Rightarrow x^2=1,\ 9\Rightarrow x=1,\ 9$$
Scores M1A1M1A0 (BOD)

Attempts to solve $x^4-10x^2+9=0$ by identifying roots/factors and then using e.g. long division should be sent to review.

Part (a) may also be done without obtaining a quartic:

$$y = x^2 + 3,\ y = 13 - \frac{9}{x^2} \Rightarrow x^2 + 3 = 13 - \frac{9}{x^2} \Rightarrow x^2 - 10 + \frac{9}{x^2} = 0$$

$$\Rightarrow \left(x - \frac{9}{x}\right)\left(x - \frac{1}{x}\right) = 0$$

$$x - \frac{9}{x} = 0 \Rightarrow x^2 = 9 \Rightarrow x = 3 \quad \text{or} \quad x - \frac{1}{x} = 0 \Rightarrow x^2 = 1 \Rightarrow x = 1$$

M1: Solves simultaneously and attempts to factorise to $\left(x - \frac{\alpha}{x}\right)\left(x - \frac{\beta}{x}\right) = 0$

A1: Correct factorisation

M1: Attempts to solve via x^2

A1: $x = 1$ and $x = 3$. Both correct and no other values. Condone any confusion with which is P and which is Q and condone e.g. $P = 1$, $Q = 3$

Part (a) may also be done via y e.g.:

$$y = x^2 + 3,\ y = 13 - \frac{9}{x^2} \Rightarrow y = 13 - \frac{9}{y - 3} \Rightarrow y^2 - 16y + 48 = 0$$

$$y^2 - 16y + 48 = 0 \Rightarrow y = 4, 12$$

$$y = 4 \Rightarrow x = 1,\ y = 12 \Rightarrow x = 3$$

M1: Solves simultaneously to obtain a 3TQ in y

A1: Correct 3TQ in y

M1: Solves their 3TQ in y and uses at least one value of y to find a value for x

A1: $x = 1$ and $x = 3$. Both correct and no other values. Condone any confusion with which is P and which is Q and condone e.g. $P = 1$, $Q = 3$

(b)	$\int\left\{13-\frac{9}{x^2}-\left(x^2+3\right)\right\}\mathrm{d}x=13x+\frac{9}{x}-\frac{x^3}{3}-3x\left(+c\right)$ or $\int\left(13-\frac{9}{x^2}\right)\mathrm{d}x=13x+\frac{9}{x}\left(+c\right),\ \int\left(x^2+3\right)\mathrm{d}x=\frac{x^3}{3}+3x\left(+c\right)$	M1A1
	$\left[10x+\frac{9}{x}-\frac{x^3}{3}\right]_1^3=10\left(3\right)+\frac{9}{3}-\frac{3^3}{3}-\left(10+9-\frac{1}{3}\right)=...$ or $\left[13x+\frac{9}{x}\right]_1^3-\left[\frac{x^3}{3}+3x\right]_1^3=39+3-\left(13+9\right)-\left\{9+9-\left(\frac{1}{3}+3\right)\right\}=...$	**d**M1
	$=\frac{16}{3}$	A1
		(4)
		Total 8

Note that this question has the calculator warning so attempts that do not use algebraic integration score no marks.

(b)

M1: Evidence of integration $x^n \to x^{n+1}$ for at least one term for either **curve** or for the difference between the **2 curves** e.g. it is not for integrating x^4-10x^2+9

A1: Correct integration for both curves either as a difference (either way round) or separately. E.g. $\pm\left(13x+\frac{9}{x}-\frac{x^3}{3}-3x\left(+c\right)\right)$ or $13x+\frac{9}{x}$ and $\frac{x^3}{3}+3x$

Allow simplified or unsimplified but indices must be processed.

dM1: **Depends on the first method mark.**

Substitutes their positive values from part (a) and subtracts if attempted as a difference or substitutes their values into the separate integrations, subtracts and then subtracts the 2 results either way round to obtain a value.

Condone poor bracketing as long as the intention is clear.

May be implied by the correct final answer following correct integration.

If the integration and/or limits are incorrect **and** the substitution is not shown explicitly **then** you may need to check.

A1: $\frac{16}{3}$ or **exact** equivalent. $-\frac{16}{3}$ scores A0 unless it gets corrected to $+\frac{16}{3}$