Question Number	Scheme	Marks
9 (i)	Method of finding r e.g. $r^4 = \dfrac{130}{22}$	M1
	$(r =)$ awrt 1.6	A1
	Max speed in second gear is $22 \times "1.559" =$ awrt 34.3 (kmh^{-1})	dM1A1 **(4)**
(ii)(a)	e.g. $u_n = 208 + (n-1) \times (-0.8) = 0 \Rightarrow n = ...$	M1
	$(n =)$ 261 (or 260) (allow 260.5 see notes)	A1
	e.g. $S_{"261"} = \dfrac{"261"}{2}\left(2 \times 208 + (n-1) \times (-0.8)\right)$	dM1
	Maximum $S_n = 27144$	A1 **(4)**
(b)	522	B1 **(1)**
		(9 marks)

(i)

M1: Either a correct equation in r only e.g. $22r^4 = 130$ or states $a = 22$ and forms a correct equation in a and r e.g. $a = 22, ar^4 = 130$. May be implied by a correct expression for r, which may be part of their calculation to find the maximum speed in second gear.

A1: awrt 1.6. Accept $\sqrt[4]{\dfrac{130}{22}}$ or $\sqrt[4]{\dfrac{65}{11}}$ May be seen within a calculation or implied by awrt 34.3

dM1: For attempting $22 \times "1.559"$ It is dependent on the previous method mark.

A1: awrt $34.3\left(\text{kmh}^{-1}\right)$ Units are not required

(ii)(a) Note candidates must show all stages of their working. Solutions relying entirely on calculator technology are not acceptable. A correct answer only or a correct answer with only 260 or 261 stated send to review.

M1: For an acceptable method of finding the number of terms required to find the maximum value of S. e.g. finds n by e.g. using $u_n = 208 + (n-1)(-0.8) = 0$ (condone missing brackets around -0.8) or alternatively score for $\dfrac{208}{0.8}$. Allow to show trial calculations of $u_{260} = 0.8$ or $u_{261} = 0$. May be implied by 260 or 261

Alternatively sets $S_n = \dfrac{n}{2}\left[2 \times 208 + (n-1) \times (-0.8)\right]$ and either

- differentiates and sets = 0 : $S_n = 208.4n - 0.4n^2 \Rightarrow 208.4 - 0.8n = 0 \Rightarrow n = ...$ look for $n^k \rightarrow n^{k-1}$ for at least one term, set the result equal to zero and finds n (condone slips in the rearrangement)
- uses roots: $S_n = 208.4n - 0.4n^2 = 0 \Rightarrow n(208.4 - 0.4n) = 0 \Rightarrow n = 0,\ n = ...$ and then finds the midpoint of the two roots
- completes the square: $S_n = 208.4n - 0.4n^2 = 0 \Rightarrow -0.4\left(n^2 - 521n\right) \Rightarrow -0.4\left(n - 260.5\right)^2 \pm ... \Rightarrow n = ...$

to find the position of the turning point

A1: 260 or 261 terms required for maximum S_n (condone 260.5 or $\frac{521}{2}$ if using the sum formula)

dM1: Attempts $S_{"261"} = \frac{"261"}{2}\left(2(208)+(n-1)(-0.8)\right)$ or $S_{"260"} = \frac{"260"}{2}\left(2(208)+(n-1)(-0.8)\right)$

Alternatively attempts $S_{"260"} = \frac{"260"}{2}\left(208+"0.8"\right)$ or $S_{"261"} = \frac{"261"}{2}\left(208+"0"\right)$

They must have the correct combination of values. It is dependent on the previous method mark. Condone missing brackets around -0.8

The value for *n* must be an integer which cannot be implied. It must be stated or seen embedded in the sum formula. If the integer value of *n* is stated and they proceed directly to an answer with no method shown then you may need to check this.

A1: 27144 cao **following sight of 260 or 261**

There are other alternative methods which may be credit worthy.
If they use trial and improvement send to review.

(ii)(b)

B1 522 cao

Question Number	Scheme	Marks
10. (a)	Sets $30 = 2r^2 + 2r^2\theta + 2r^2\theta$	M1
	Obtains $4r\theta = \frac{30-2r^2}{r}$ oe or $\theta = \frac{30-2r^2}{4r^2}$ oe or $r\theta = \frac{30-2r^2}{4r}$ oe	A1
	Uses $P = 6r + 4r\theta$ with their θ or $...r\theta$ substituted	dM1
	$P = 6r + \frac{30-2r^2}{r} = 4r + \frac{30}{r}$ *	A1*
		(4)
(b)	Differentiates with $r^{-1} \to r^{-2}$	M1
	$\left(\frac{dP}{dr} =\right) 4 - \frac{30}{r^2}$	A1
	Solves $\frac{dP}{dr} = 0 \Rightarrow \left(r = \sqrt{\frac{15}{2}}\right)$ and substitutes to find P	dM1
	$\left(P = 4\sqrt{\frac{15}{2}} + \frac{30\sqrt{2}}{\sqrt{15}} = 2\sqrt{30} + 2\sqrt{30}\right) = 4\sqrt{30}$	A1
		(4)
(c)	e.g. finds $\left(\frac{d^2P}{dr^2} =\right) \frac{60}{r^3} = \frac{60}{"2.7"^3} = ...$	M1
	e.g. states that $\left(\frac{d^2P}{dr^2} =\right)$ awrt $3 > 0$ hence minimum	A1
		(2)
		(10 marks)

(a) **Note that using θ as an angle in degrees can only score a maximum of M1A0dM1A0***

M1: Uses the area is 30 m^2 to form an equation of an allowable form.

Condone slips/incorrect formulae but score for a form $30 = Ar^2 + Br^2\theta$ oe which may be unsimplified.