Question	Scheme	Marks	AOs
8 (a)(i)	$C=\frac{1500}{v}+\frac{2v}{11}+60\Rightarrow\frac{\mathrm{d}C}{\mathrm{d}v}=-\frac{1500}{v^2}+\frac{2}{11}$	M1 A1	3.1b 1.1b
	Sets $\frac{\mathrm{d}C}{\mathrm{d}v}=0\Rightarrow v^2=8250$	M1	1.1b
	$\Rightarrow v=\sqrt{8250}\Rightarrow v=90.8\,(\mathrm{km\,h^{-1}})$	A1	1.1b
(ii)	For substituting their $v=90.8$ in $C=\frac{1500}{v}+\frac{2v}{11}+60$	M1	3.4
	Minimum cost =awrt (£) 93	A1 ft	1.1b
		(6)	
(b)	Finds $\frac{\mathrm{d}^2C}{\mathrm{d}v^2}=+\frac{3000}{v^3}$ at $v=90.8$	M1	1.1b
	$\frac{\mathrm{d}^2C}{\mathrm{d}v^2}=(+0.004)>0$ hence minimum (cost)	A1 ft	2.4
		(2)	
(c)	It would be impossible to drive at this speed over the whole journey	B1	3.5b
		(1)	
			(9 marks)

Notes

(a)(i)

M1: Attempts to differentiate (deals with the powers of v correctly).

Look for an expression for $\frac{\mathrm{d}C}{\mathrm{d}v}$ in the form $\frac{A}{v^2}+B$

A1: $\left(\frac{\mathrm{d}C}{\mathrm{d}v}\right)=-\frac{1500}{v^2}+\frac{2}{11}$

A number of students are solving part (a) numerically or graphically. Allow these students to pick up the M1 A1 here from part (b) when they attempt the second derivative.

M1: Sets $\frac{\mathrm{d}C}{\mathrm{d}v}=0$ (which may be implied) and proceeds to an equation of the type $v^n=k, k>0$

Allow here equations of the type $\frac{1}{v^n}=k, k>0$

A1: $v=\sqrt{8250}$ or $5\sqrt{330}$ awrt $90.8\,(\mathrm{km\,h^{-1}})$.

As this is a speed withhold this mark for answers such as $v=\pm\sqrt{8250}$

***** Condone $\frac{\mathrm{d}C}{\mathrm{d}v}$ appearing as $\frac{\mathrm{d}y}{\mathrm{d}x}$ or perhaps not appearing at all. Just look for the rhs.

(a)(ii)

M1: For a correct method of finding C = from their solution to $\frac{\mathrm{d}C}{\mathrm{d}v} = 0$.

Do not accept attempts using negative values of v.
Award if you see $v = .., C = ...$ where the v used is their solution to (a)(i).

A1ft: Minimum cost = awrt (£) 93. Condone the omission of units
Follow through on sensible values of v. $60 < v < 110$

v	C
60	95.9
65	94.9
70	94.2
75	93.6
80	93.3
85	93.1
90	93.0
95	93.1
100	93.2
105	93.4
110	93.6

(b)

M1: Finds $\frac{\mathrm{d}^2C}{\mathrm{d}v^2}$ **(**following through on their $\frac{\mathrm{d}C}{\mathrm{d}v}$ which must be of equivalent difficulty) and attempts to find its value / sign at their v

Allow a substitution of their answer to (a) (i) in their $\frac{\mathrm{d}^2C}{\mathrm{d}v^2}$

Allow an explanation into the sign of $\frac{\mathrm{d}^2C}{\mathrm{d}v^2}$ from its terms (as $v > 0$)

A1ft: $\frac{\mathrm{d}^2C}{\mathrm{d}v^2} = +0.004 > 0$ hence minimum (cost). Alternatively $\frac{\mathrm{d}^2C}{\mathrm{d}v^2} = +\frac{3000}{v^3} > 0$ as $v > 0$

Requires a correct calculation or expression, a correct statement and a correct conclusion.

Follow through on their v ($v > 0$) and their $\frac{\mathrm{d}^2C}{\mathrm{d}v^2}$

* Condone $\frac{\mathrm{d}^2C}{\mathrm{d}v^2}$ appearing as $\frac{\mathrm{d}^2y}{\mathrm{d}x^2}$ or not appearing at all for the M1 but for the A1 the correct notation must be used (accept notation C'').

(c)

B1: Gives a limitation of the given model, for example

- It would be impossible to drive at this speed over the whole journey
- The traffic would mean that you cannot drive at a constant speed

Any statement that implies that the speed could not be constant is acceptable.