

- 14 The velocity of a car, $v \text{ m s}^{-1}$ at time t seconds, is being modelled. Initially the car has velocity 5 m s^{-1} and it accelerates to 11.4 m s^{-1} in 4 seconds.

In model A, the acceleration is assumed to be uniform.

- (i) Find an expression for the velocity of the car at time t using this model. [3]
- (ii) Explain why this model is not appropriate in the long term. [1]

Model A is refined so that the velocity remains constant once the car reaches 17.8 m s^{-1} .

- (iii) Sketch a velocity-time graph for the motion of the car, making clear the time at which the acceleration changes. [3]
- (iv) Calculate the displacement of the car in the first 20 seconds according to this refined model. [3]

In model B, the velocity of the car is given by

$$v = \begin{cases} 5 + 0.6t^2 - 0.05t^3 & \text{for } 0 \leq t \leq 8, \\ 17.8 & \text{for } 8 < t \leq 20. \end{cases}$$

- (v) Show that this model gives an appropriate value for v when $t = 4$. [1]
- (vi) Explain why the value of the acceleration immediately before the velocity becomes constant is likely to mean that model B is a better model than model A. [3]
- (vii) Show that model B gives the same value as model A for the displacement at time 20 s. [3]