

Solutionbank M1

Heinemann Modular Maths for Edexcel AS and A-level

2 Kinematics in one dimension

Exercise A, Question 12

Question:

Two sprinters compete in a 100 m race, crossing the finishing line together after 12 seconds. The two models, A and B, as described below, are models for the motions of the two sprinters.

Model A. The sprinter accelerates from rest at a constant rate for 4 seconds and then travels at a constant speed for the rest of the race.

Model B. The sprinter accelerates from rest at a constant rate until reaching a speed of 9 m s^{-1} and then travels at this speed for the rest of the race.

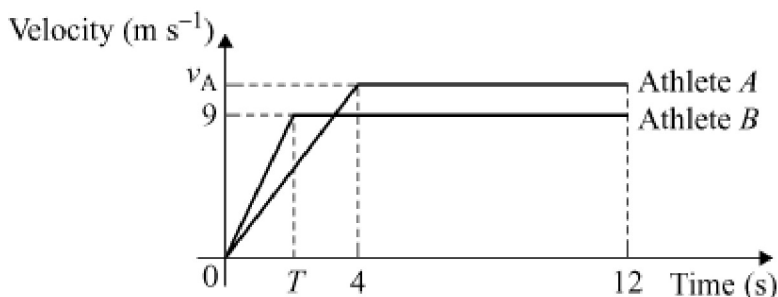
(a) Sketch velocity-time graphs for each model.

(b) For model A, find the maximum speed and the initial acceleration of the sprinter.

(c) For model B, find the time taken to reach the maximum speed and the initial acceleration of the sprinter.
[A]

Solution:

(a)



(b)

$$\text{Using distance } \left[\frac{1}{2} \times 4 \times v_A \right] + \left[(12 - 4) \times v_A \right] = 100$$

$$\therefore 2v_A + 8v_A = 100, \text{ i.e. } 10v_A = 100$$

$$\therefore v_A = 10 \text{ m s}^{-1} \text{ is the maximum speed.}$$

$$\text{initial acceleration} = \frac{10 \text{ m s}^{-1}}{4 \text{ s}} = 2.5 \text{ m s}^{-2}$$

(c)

$$\therefore 8$$

$$= 4.5T \text{ (multiply both sides by 2)}$$

$$\therefore 16$$

$$= 9T$$

i.e. T

$$= \frac{16}{9} \text{ seconds}$$

initial acceleration

$$= \frac{9}{\left(\frac{16}{9}\right)} = 5 \frac{1}{16} \text{ m s}^{-2} \text{ or } 5.06 \text{ m s}^{-2} \text{ (3}$$

s.f.)