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**8.**

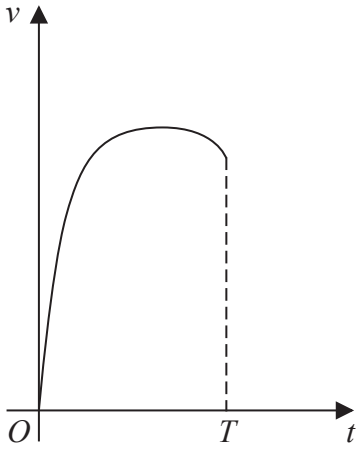



**Figure 4**

Figure 4 is a graph showing the velocity of a sprinter during a 100 m race.

The sprinter's velocity during the race, $v\,\text{m}\,\text{s}^{-1}$, is modelled by the equation

$$v = 12 - \text{e}^{t-10} - 12\text{e}^{-0.75t} \qquad t \geqslant 0$$

where $t$ seconds is the time after the sprinter begins to run.

According to the model,

(a) find, using calculus, the sprinter's maximum velocity during the race.

**(5)**

Given that the sprinter runs 100 m in $T$ seconds, such that

$$\int_0^T v\,\text{d}t = 100$$

(b) show that $T$ is a solution of the equation

$$T = \frac{1}{12}\left(116 - 16\text{e}^{-0.75T} + \text{e}^{T-10} - \text{e}^{-10}\right)$$

**(4)**

The iteration formula

$$T_{n+1} = \frac{1}{12}\left(116 - 16\text{e}^{-0.75T_n} + \text{e}^{T_n-10} - \text{e}^{-10}\right)$$

is used to find an approximate value for $T$

Using this iteration formula with $T_1 = 10$

(c) find, to 4 decimal places,

(i) the value of $T_2$

(ii) the time taken by the sprinter to run the race, according to the model.

**(3)**

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**Question 8 continued**

**Q8**

**(Total 12 marks)**

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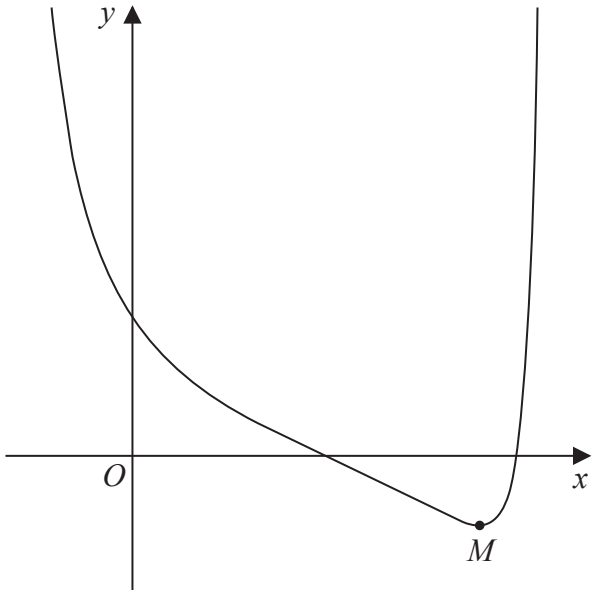



**Figure 5**

**In this question you must show all stages of your working.**

**Solutions relying entirely on calculator technology are not acceptable.**

Figure 5 shows the curve with equation

$$y = \frac{1 + 2\cos x}{1 + \sin x} \qquad -\frac{\pi}{2} < x < \frac{3\pi}{2}$$

The point $M$, shown in Figure 5, is the minimum point on the curve.

(a) Show that the $x$ coordinate of $M$ is a solution of the equation

$$2\sin x + \cos x = -2$$

**(4)**

(b) Hence find, to 3 significant figures, the $x$ coordinate of $M$.

**(5)**

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