



2.

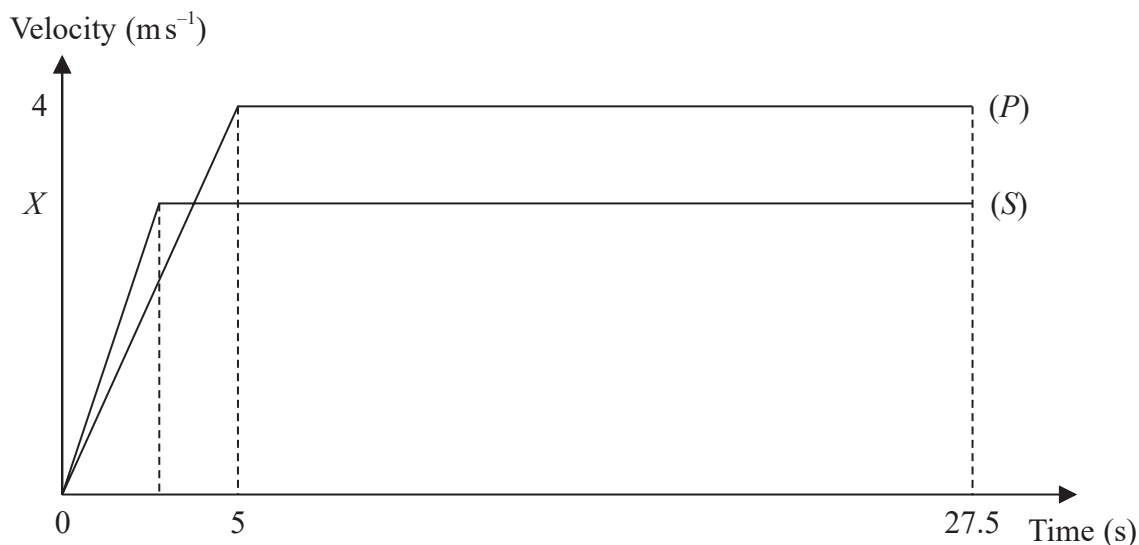


Figure 1

Two children, Pat ( $P$ ) and Sam ( $S$ ), run a race along a straight horizontal track.

Both children start from rest at the same time and cross the finish line at the same time.

In a model of the motion:

Pat accelerates at a constant rate from rest for 5 s until reaching a speed of  $4 \text{ m s}^{-1}$  and then maintains a constant speed of  $4 \text{ m s}^{-1}$  until crossing the finish line.

Sam accelerates at a constant rate of  $1 \text{ m s}^{-2}$  from rest until reaching a speed of  $X \text{ m s}^{-1}$  and then maintains a constant speed of  $X \text{ m s}^{-1}$  until crossing the finish line.

Both children take 27.5 s to complete the race.

The velocity-time graphs shown in Figure 1 describe the model of the motion of each child from the instant they start to the instant they cross the finish line together.

Using the model,

- (a) explain why the areas under the two graphs are equal, (1)
- (b) find the acceleration of Pat during the first 5 seconds, (1)
- (c) find, in metres, the length of the race, (2)
- (d) find the value of  $X$ , giving your answer to 3 significant figures. (4)

