

Problem 7-22

Let acceleration time = $t_a = 3.80$ s

Then, constant-velocity time = $t_v = (9.90 - 3.80)$ s
= 6.10 s

Distance travelled while accelerating

$$= x_a = x_0 + v_0 t_a + \frac{1}{2} a t_a^2$$

↑ ↑
choose assume
 $x_0 = 0$ $v_0 = 0$

$$\therefore x_a = \frac{1}{2} a t_a^2 \quad [1]$$

At end of acceleration phase,

$$v = v_0 + a t_a = a t_a$$

↑
0

The runner travels at this v for a time t_v ,
and the distance travelled is

$$x_v = v t_v$$

$$\therefore x_v = a t_a t_v \quad [2]$$

The total distance is 100 m.

\therefore from [1] & [2],

$$100 = \frac{1}{2} a t_a^2 + a t_a t_v$$

$$= a \left(\frac{1}{2} t_a^2 + t_a t_v \right)$$

$$\therefore 100 = a \left[\frac{1}{2} [3.80]^2 + [3.80][6.10] \right]$$

$$\therefore a = 3.29 \text{ m/s}^2$$