Book solution

P2.45 Average speed of every point on the train as the first car passes Liz:

$$\frac{\Delta x}{\Delta t} = \frac{8.60 \text{ m}}{1.50 \text{ s}} = 5.73 \text{ m/s}.$$

The train has this as its instantaneous speed halfway through the 1.50 s time. Similarly, halfway through the next 1.10 s, the speed of the train is $\frac{8.60 \text{ m}}{1.10 \text{ s}} = 7.82 \text{ m/s}$. The time required for the speed to change from 5.73 m/s to 7.82 m/s is

$$\frac{1}{2}(1.50 \text{ s}) + \frac{1}{2}(1.10 \text{ s}) = 1.30 \text{ s}$$

so the acceleration is: $a_x = \frac{\Delta v_x}{\Delta t} = \frac{7.82 \text{ m/s} - 5.73 \text{ m/s}}{1.30 \text{ s}} = \boxed{1.60 \text{ m/s}^2}$.

Reynolds solution

We can break up the (constant acceleration) motion into two time intervals, bounded by 3 time (and displacements)

t_1 t_2 t_3 let $t_1 = 0$ s, $x_1 = 0$ m

x_1 x_2 x_3

we know $t_2 = 1.5$ s $t_3 = 2.6$ s, $x_2 = 8.6$ m $x_3 = 17.2$ m

Applying the first kinematic equation to the points t_2 and t_3, we get two equations

(1) $x_2 = v_1 t_2 + \frac{1}{2} a t_2^2$

(2) $x_3 = v_1 t_3 + \frac{1}{2} a t_3^2$

and there are 2 unknowns: v_1, a

solving (1) for $v_1 = \dfrac{x_2 - \frac{1}{2} a t_2^2}{t_2}$

and plugging that value in to (2)

$$x_3 = \left(\frac{x_2 - \frac{1}{2} a t_2^2}{t_2}\right) t_3 + \frac{1}{2} a t_3^2$$

Now, we can solve for a

$$a = \frac{2}{t_3 - t_2}\left(\frac{x_3}{t_3} - \frac{x_2}{t_2}\right) = \boxed{1.60 \frac{\text{m}}{\text{s}^2}}$$