

**Constant acceleration 9B**

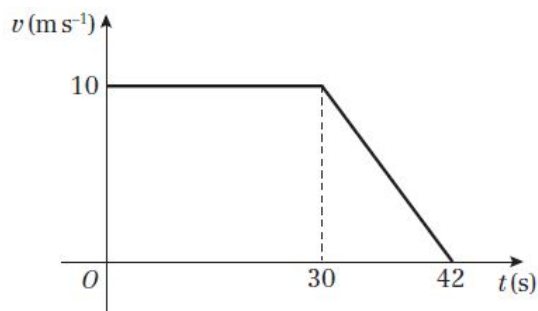
**1 a**  $a = \frac{9}{4} = 2.25$

The athlete accelerates at a rate of  $2.25 \text{ m s}^{-2}$ .

**b**  $s = \frac{1}{2}(a + b)h$

$$= \frac{1}{2}(8 + 12) \times 9 = 90$$

The displacement of the athlete after 12 s is 90 m.

**2 a**


**b**  $s = \frac{1}{2}(a + b)h$

$$= \frac{1}{2}(30 + 42) \times 10 = 360$$

The distance from A to B is 360 m.

**3 a**  $a = \frac{8}{20} = 0.4$

The acceleration of the cyclist is  $0.4 \text{ m s}^{-2}$ .

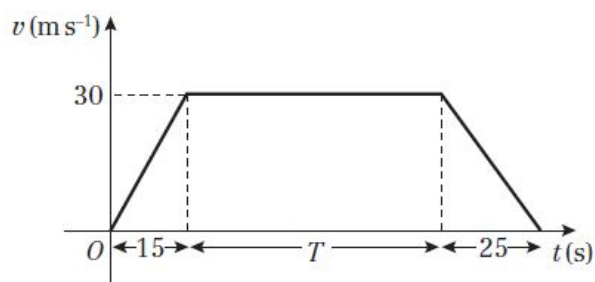
**b**  $a = -\frac{8}{15} = -0.533$  (to 3 s.f.)

The deceleration of the cyclist is  $0.533 \text{ m s}^{-2}$ .

**c**  $s = \frac{1}{2}(a + b)h$

$$= \frac{1}{2}(40 + 75) \times 8 = 460$$

After 75 s, the displacement of the cyclist is 460 m.

**4 a**


**4 b**  $s = \frac{1}{2}(a+b)h$

$$2400 = \frac{1}{2}(T + (15 + T + 25)) \times 30$$

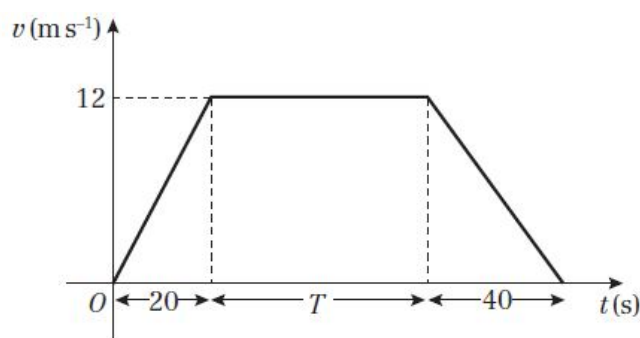
$$= 15(2T + 40)$$

$$2T + 40 = \frac{2400}{15} = 160$$

$$T = \frac{160 - 40}{2} = 60$$

The time taken to travel from *S* to *F* is  $(15 + T + 25) = 100$  s.

**5 a** The velocity after 20 s is given by



$$\text{velocity} = \text{acceleration} \times \text{time} = 0.6 \times 20 = 12$$

**b**  $s = \frac{1}{2}(a+b)h$

$$4200 = \frac{1}{2}(T + (20 + T + 40)) \times 12$$

$$= 6(2T + 60)$$

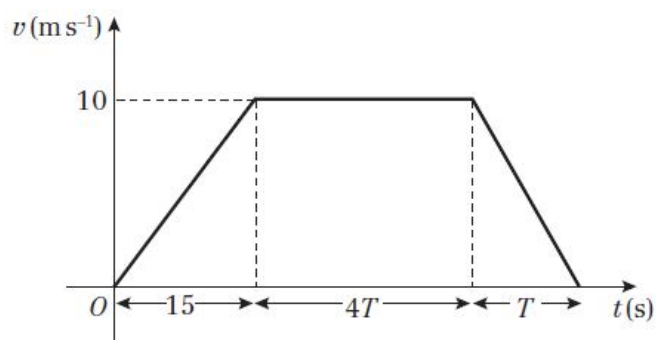
$$2T + 60 = \frac{4200}{6} = 700$$

$$T = \frac{700 - 60}{2} = 320$$

**c** While at constant velocity:  $v = 12 \text{ m s}^{-1}$ ,  $t = 320$  s

$$\text{distance travelled} = 12 \times 320 = 3840 \text{ m}$$

**6 a**



$$6 \text{ b } s = \frac{1}{2}(a+b)h$$

$$480 = \frac{1}{2}(4T + (15 + 4T + T))10$$

$$= 5 \times (15 + 9T)$$

$$9T + 15 = \frac{480}{5} = 96$$

$$T = \frac{96 - 15}{9} = 9$$

$$\text{Total time travelling} = 15 + 5T = 15 + (5 \times 9) = 60$$

The particle travels for a total of 60 s.

$$7 \text{ a } \text{Area} = \text{trapezium} + \text{rectangle} + \text{triangle}$$

$$100 = \frac{1}{2}(u + 10) \times 3 + 7 \times 10 + \frac{1}{2} \times 2 \times 10$$

$$= \frac{3}{2}(u + 10) + 70 + 10$$

$$\frac{3}{2}(u + 10) = 100 - 70 - 10 = 20$$

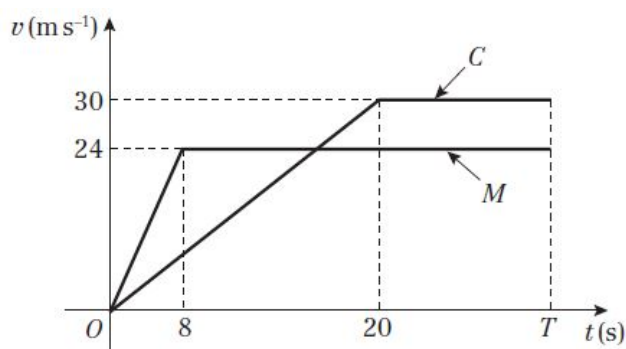
$$u = 20 \times \frac{2}{3} - 10$$

$$= \frac{10}{3}$$

$$b \text{ } a = \frac{10 - \frac{10}{3}}{3} = \frac{20}{9} = 2.22 \text{ (to 3 s.f.)}$$

The acceleration of the particle is  $2.22 \text{ m s}^{-2}$ .

$$8 \text{ a } \text{For } M, \text{ velocity} = \text{acceleration} \times \text{time} = 3 \times 8 = 24$$



$$b \text{ Let } C \text{ overtake } M \text{ at time } T \text{ seconds.}$$

The distance travelled by M is given by

$$s = \frac{1}{2}(8 \times 24) + 24 \times (T - 8)$$

$$= 24(T - 4)$$

**8 b** The distance travelled by  $C$  is given by

$$\begin{aligned} s &= \frac{1}{2}(a+b)h = \frac{1}{2}(T-20+T) \times 30 \\ &= 15(2T-20) \end{aligned}$$

At the point of overtaking the distances are equal.

$$24(T-4) = 15(2T-20)$$

$$24T - 96 = 30T - 300$$

$$6T = 204$$

$$T = \frac{204}{6} = 34$$

$$s = 24(T-4)$$

$$= 24(34-4) = 720$$

The distance of the pedestrian from the road junction is 720 m.

### Challenge

**a** The object changed direction after 6 s, as this is when the velocity changed from positive to negative.

**b** While travelling at positive velocity:

$$s_p = \frac{1}{2}(1+6) \times 3 = \frac{1}{2} \times 21 = 10.5$$

While travelling at negative velocity:

$$s_n = \frac{1}{2}(4+2) \times 2 = \frac{1}{2} \times 12 = 6$$

The total distance travelled by the object =  $s_p + s_n = 10.5 + 6 = 16.5$  m

**c i** Using the value calculated in **b**, after 6 s the displacement of the object is  $s_p = 10.5$  m.

**ii** In the first 6 seconds, displacement is positive.

In the last 4 seconds, displacement is negative.

Hence, using the values calculated in **b**, total displacement =  $s_p + (-s_n) = 10.5 + (-6) = 4.5$  m.