Constant acceleration 9B

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

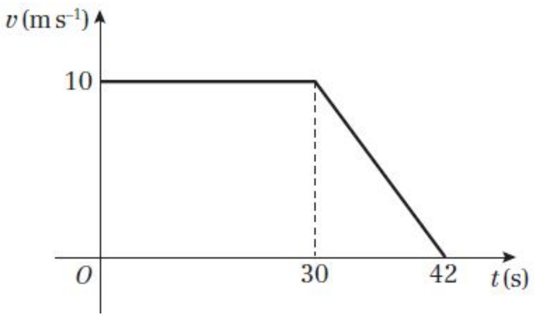
The athlete accelerates at a rate of 2.25 m s^{-2}.

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 m s^{-2}.

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

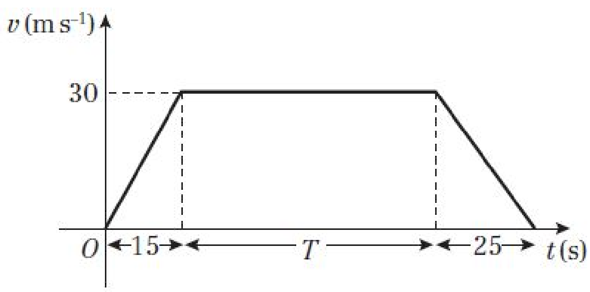
The deceleration of the cyclist is 0.533 m s^{-2}.

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

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

After 75 s, the distance from the starting point of the cyclist is 460 m.

4 a



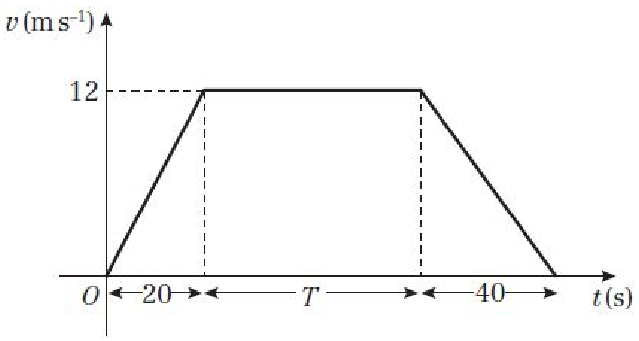
4 b $s = \frac{1}{2}(a+b)h$

$$2400 = \tfrac{1}{2}(T + (15 + T + 25)) \times 30$$
$$= 15(2T + 40)$$
$$2T + 40 = \tfrac{2400}{15} = 160$$

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

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



velocity = acceleration x time $= 0.6 \times 20 = 12$

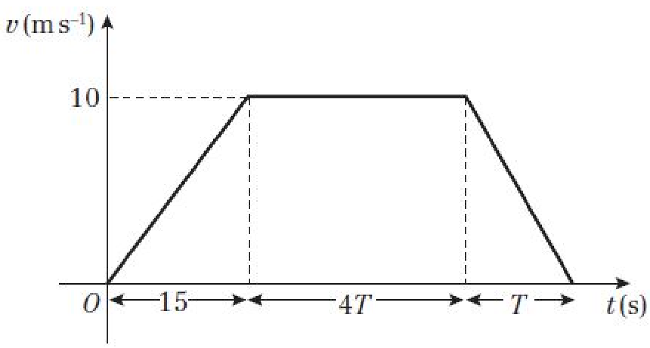
b $s = \frac{1}{2}(a+b)h$

$$4200 = \tfrac{1}{2}(T + (20 + T + 40)) \times 12$$
$$= 6(2T + 60)$$
$$2T + 60 = \frac{4200}{6} = 700$$
$$T = \frac{700 - 60}{2} = 320$$

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

distance travelled = 12 × 320 = 3840 m

6 a



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

$$480 = \tfrac{1}{2}(4T + (15 + 4T + T))10$$
$$= 5 \times (15 + 9T)$$
$$9T + 15 = \frac{480}{5} = 96$$

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

Total time travelling = 15 + 5T = 15 + (5 × 9) = 60

The particle travels for a total of 60 s.

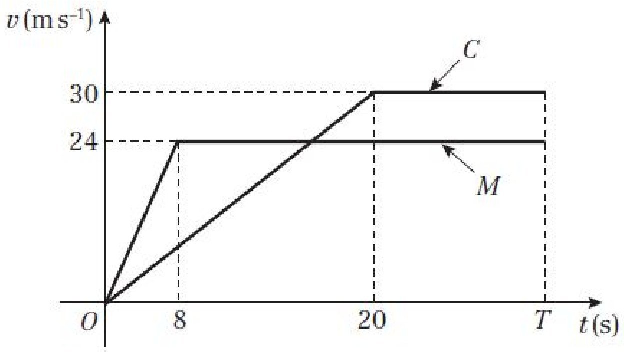
7 a Area = trapezium + rectangle + triangle

$$100 = \tfrac{1}{2}(u+10)\times 3 + 7\times 10 + \tfrac{1}{2}\times 2\times 10$$
$$= \tfrac{3}{2}(u+10) + 70 + 10$$
$$\tfrac{3}{2}(u+10) = 100 - 70 - 10 = 20$$
$$u = 20 \times \tfrac{2}{3} - 10$$
$$= \tfrac{10}{3}$$

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

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

8 a For M, velocity = acceleration x time = $3 \times 8 = 24$



b Let C overtake M at time T 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

$$s = \tfrac{1}{2}(a+b)h = \tfrac{1}{2}(T-20+T)\times 30$$
$$= 15\,(2T-20)$$

At the point of overtaking the distances are equal.

$$24(T-4) = 15(2T-20)$$
$$24T-96 = 30T-300$$
$$6T = 204$$
$$T = \tfrac{204}{6} = 34$$

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

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:

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

While travelling at negative velocity:

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

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.

d