Section 2: Velocity and acceleration

Solutions to Exercise level 1

1. (i) Acceleration is the gradient of the graph in the first 10 seconds.

$\text{Gradient} = \frac{30}{10} = 3$

$\text{Acceleration} = 3\ \text{ms}^{-2}$.

(ii) Gradient of graph in last 5 seconds $= -\frac{30}{5} = -6$

$\text{Deceleration} = 6\ \text{ms}^{-2}$.

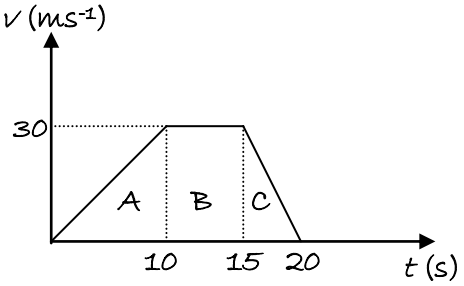
(iii) Total distance travelled = area under graph

$\text{Area A} = \frac{1}{2} \times 10 \times 30 = 150$

$\text{Area B} = 5 \times 30 = 150$

$\text{Area C} = \frac{1}{2} \times 5 \times 30 = 75$

$\text{Total distance travelled} = 375\ \text{m}$.



2. (i) $OA = \frac{2}{5} = 0.4\ \text{m s}^{-2}$

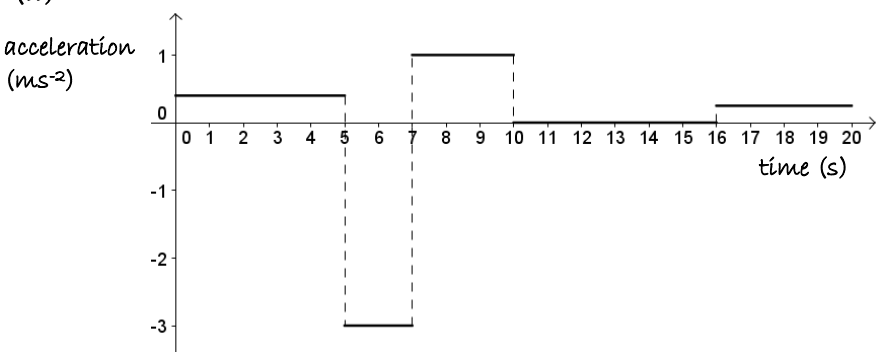
$AB = \frac{-6}{2} = -3\ \text{m s}^{-2}$

$BC = \frac{3}{3} = 1\ \text{m s}^{-2}$

$CD = 0\ \text{m s}^{-2}$

$DE = \frac{1}{4} = 0.25\ \text{m s}^{-2}$

(ii)

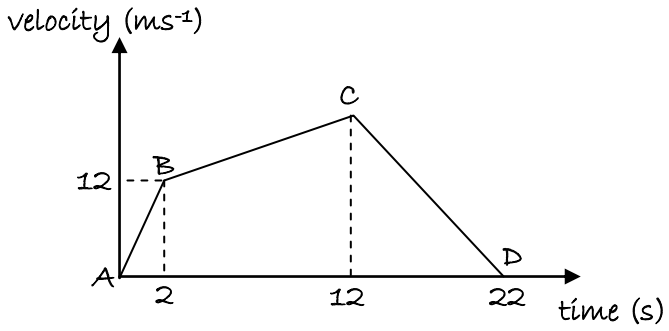


3. (i) The time for the whole journey is $3T$ seconds, so $T = 15$ seconds.

(ii) $\text{Acceleration} = \frac{-V}{2T} = -\frac{V}{30}$

$$-\frac{V}{30} = -1.5 \quad \Rightarrow V = 45 \text{ ms}^{-1}$$

4. (i)



(ii) Acceleration from A to B $= \frac{12}{2} = 6 \text{ ms}^{-2}$.

Acceleration from B to C $= 3 \text{ ms}^{-2}$

(iii) From B to C, $3 = \frac{V-12}{10}$

$$30 = V - 12$$

$$V = 42$$

The speed at C is 42 ms^{-1}.

(iv) Deceleration $= \frac{42}{10} = 4.2 \text{ ms}^{-2}$.

5. (i) 0 s to 5 s: $a = \frac{7}{5} = 1.4 \text{ m s}^{-2}$

5 s to 15 s: $a = \frac{3}{10} = 0.3 \text{ m s}^{-2}$

15 s to 18 s: $a = 0 \text{ m s}^{-2}$

18 s to 20 s: $a = \frac{-10}{2} = -5 \text{ m s}^{-2}$

(ii) 0 s to 5 s: $s = \frac{1}{2} \times 5 \times 7 = 17.5$ m

5 s to 15 s: $s = \frac{1}{2} \times 10 \times (7 + 10) = 85$ m

15 s to 18 s: $s = 10 \times 3 = 30$ m

18 s to 20 s: $s = \frac{1}{2} \times 2 \times 10 = 10$ m

Total dist $= 17.5 + 85 + 30 + 10 = 142.5$ m

(iii) Average speed $= \frac{142.5}{20} = 7.125 \text{ m s}^{-1}$

It is not a realistic model, as cars do not usually suddenly change from one constant acceleration to another constant acceleration.

6. (i) 0 s to 5 s: $a = \frac{-6}{5} = -1.2 \text{ m s}^{-2}$

5 s to 9 s: $a = \frac{-1}{4} = -0.25 \text{ m s}^{-2}$

9 s to 12 s: $a = \frac{-12}{3} = -4 \text{ m s}^{-2}$

12 s to 16 s: $a = \frac{-1}{4} = -0.25 \text{ m s}^{-2}$

(ii) 0 s to 5 s: $s = \frac{1}{2} \times 5 \times (20 + 14) = 85 \text{ m}$

5 s to 9 s: $s = \frac{1}{2} \times 4 \times (14 + 13) = 21 \text{ m}$

9 s to 12 s: $s = \frac{1}{2} \times 3 \times (13 + 1) = 21 \text{ m}$

12 s to 16 s: $s = \frac{1}{2} \times 4 \times 1 = 2 \text{ m}$

Total dist $= 85 + 54 + 21 + 2 = 162 \text{ m}$

(iii) Average speed $= \frac{162}{16} = 10.125 \text{ m s}^{-1}$