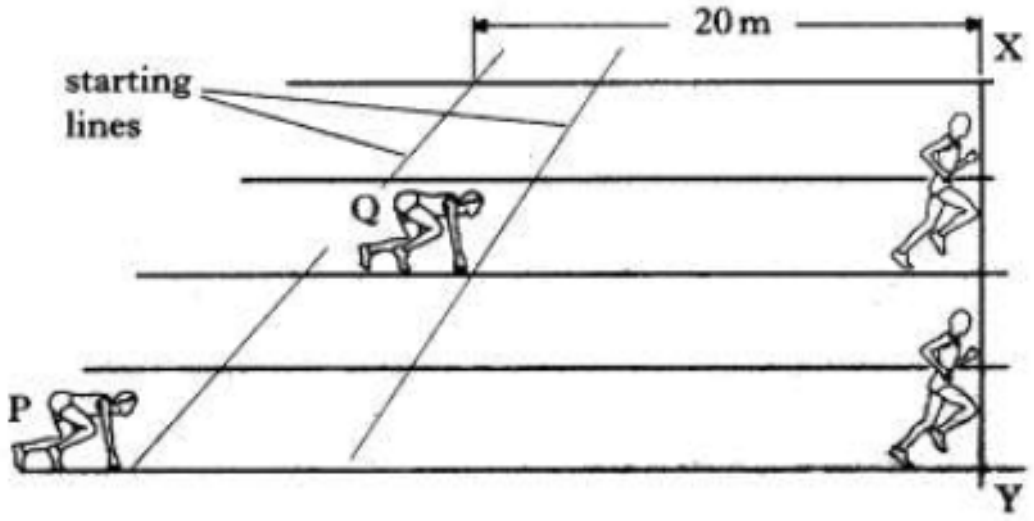
PQ 5c

Questions and Answers

In a "handicap" sprint race, sprinters P and Q both start at the same time but from different starting lines on the track.
The handicapping is such that both sprinters reach line XY, as shown below, at the same.



Sprinter P has a constant acceleration of 1·6 m s^{-2} from the start line to the line XY. Sprinter Q has a constant acceleration of 1·2 m s^{-2} from the start line to line XY.

(a) Calculate the time taken by the sprinters to reach line XY.

(b) Find the speed of **each** sprinter at this line.

(c) What is the distance, in metres, between the starting lines for sprinters P and Q?

1a) $s = ut + \frac{1}{2}at^2$

$20 = 0 + \frac{1}{2} \times 1.6 \times t^2$

$20 = 0.8t^2$

$t^2 = \frac{20}{0.8}$

$t = \sqrt{\frac{20}{0.8}}$

$= 5\text{s}$

$s = 20$

$u = 0$

$v = x$

$a = 1.6$

$t = ?$

Both sprinters take 5s.

b) $v_p = u + at$

$= 0 + 1.6 \times 5$

$v_p = \underline{\underline{8 \text{ ms}^{-1}}}$

$s = 20$

$u = 0$

$v = ?$

$a = 1.6$

$t = 5$

$v_q = u + at$

$= 0 + 1.2 \times 5$

$v_q = \underline{\underline{6 \text{ ms}^{-1}}}$

$s = 20$

$u = 0$

$v = ?$

$a = 1.2$

$t = 5$

c) $s_a = ut + \frac{1}{2}at^2$

$= 0 + \frac{1}{2} \times 1.2 \times 5^2$

$= 15m$

$s = ?$

$u = 0$

$v = 6$

$a = 1.2$

$t = 5$

$\Rightarrow$ Difference $= 20 - 15 = \underline{\underline{5m}}$

Q2

A car speeds up to 60 km/h from rest in 5 seconds. Calculate its average acceleration. (Express your answer in km/h/s.)

$$a = \frac{v - u}{t}$$

$$= \frac{60 - 0}{5}$$

$$= 12 \text{ km/h/s}$$

Q3

A train initially travelling at 30 km/h accelerates at a constant rate of 2 km/h/s for 30 seconds. Calculate its final speed.

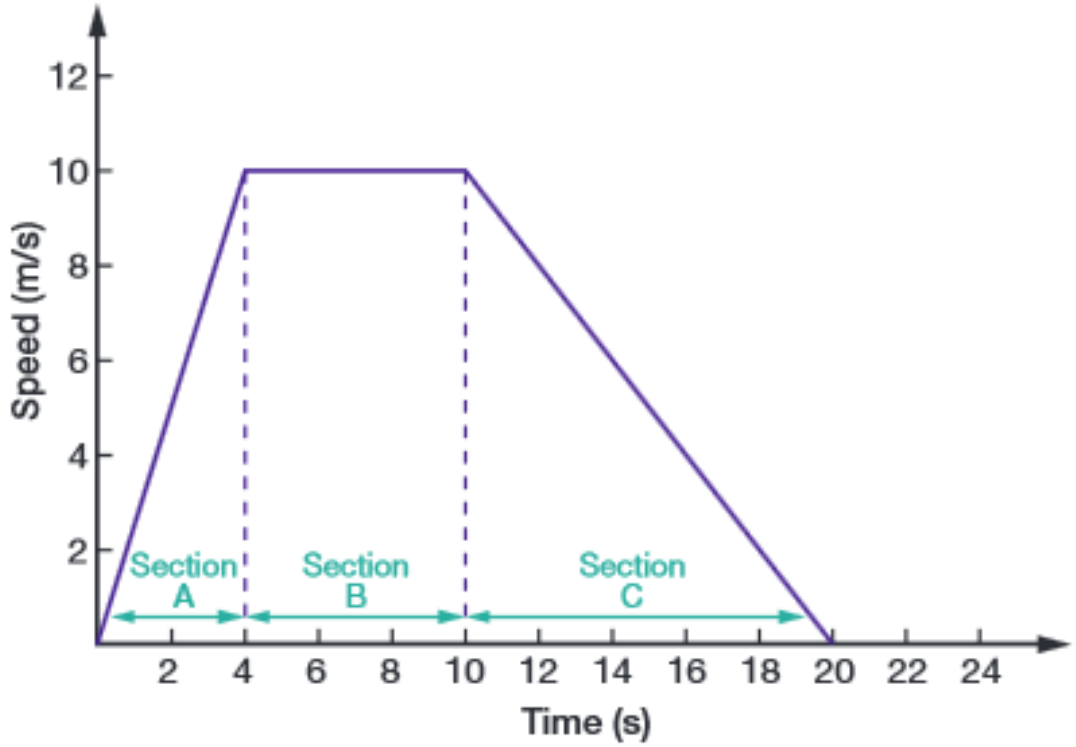
$$v = u + at$$

$$= 30 + (2 \times 30)$$

$$= 90 \text{ km/h}$$

The train is travelling at 90 km/h after 30 seconds.

Q4



Problem

Sanjiv rides his scooter as described by Figure 8.2.6.

a Calculate his acceleration in sections A, B and C of his journey.

b Describe his motion in sections A, B and C.

c Calculate the distance Sanjiv covers in section A.

Q4 continued

a Sanjiv's acceleration is the gradient of the graph in each section:

For A: acceleration $= \frac{\text{rise}}{\text{run}} = \frac{10-0}{4} = 2.5\ \text{m/s}^2$

For B: acceleration $= \frac{10-10}{10-4} = 0$

For C: acceleration $= \frac{0-10}{20-10} = -1\ \text{m/s}^2$

b In A: Sanjiv accelerates at 2.5 m/s² until reaching a velocity of 10 m/s.

In B: He travels at a constant velocity of 10 m/s (with zero acceleration).

In C: Sanjiv slows down, or decelerates at 1 m/s² until he comes to a stop.

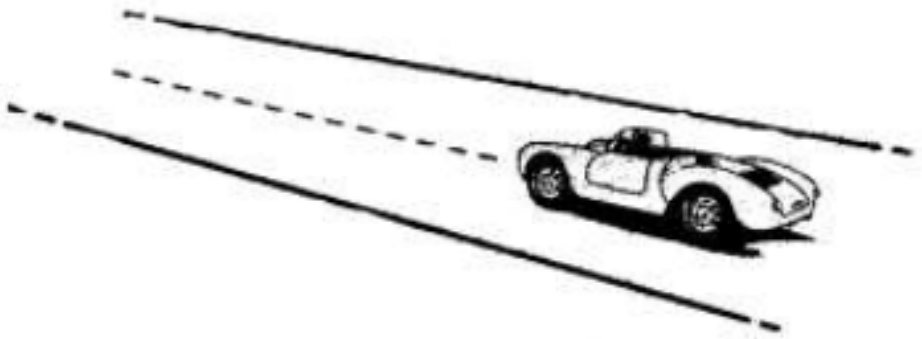
c The distance covered is the area under this section of the graph:

distance $= \frac{1}{2} \times 4 \times 10 = 20\ \text{m}$

Sanjiv travels 20 m while accelerating to 10 m/s in section A.

Q5

(a) A sports car is being tested along a straight track.



(i) In the first test, the car starts from rest and has a constant acceleration of $4{\cdot}0\ \text{m s}^{-2}$ in a straight line for 7·0 s.
Calculate the distance the car travels in the 7·0 s.

(ii) In a second test, the car again starts from rest and accelerates at $4{\cdot}0\ \text{m s}^{-2}$ over twice the distance covered in the first test.
What is the **increase** in the final speed of the car at the end of the second test compared with the final speed at the end of the first test?

(iii) In a third test, the car reaches a speed of $40\ \text{m s}^{-1}$. It then decelerates at $2{\cdot}5\ \text{m s}^{-2}$ until it comes to rest.
Calculate the distance travelled by the car while it decelerates to rest.

Q5

$s = ut + \frac{1}{2}at^2$

$= 0 + \frac{1}{2} \times 4 \times 7^2$

$= 98_m$

$s = ?$
$u = 0$
$v =$
$a = 4$
$t = 7$

$V_1 = u + at$

$= 0 + 4 \times 7$

$= 28 ms^{-1}$

$s = 98$
$u = 0$
$v = ?$
$a = 4$
$t = 7$

$V_2^2 = u^2 + 2as$

$= 0 + 2 \times 4 \times 196$

$= 1568$

$V_2 = \sqrt{1568}$

$= 39.6 ms^{-1}$

$s = 196_m$
$u = 0$
$v = ?$
$a = 4$
$t = ?$

$\Rightarrow$ Increase in speed $= 39.6 - 28$

$= 11.6 ms^{-1}$

Q6

Calculate the average speed of each of the following in the units specified in the brackets.

a Tim hikes 10 km in 2 hours in the bush (km/h).

b A frog leaps 16 m in 4 seconds (m/s).

c A racing car travels 3 km around a circuit in 6 minutes (km/h).

a Tim's average speed = = = 5 km/h

b The frog's average spe $\frac{d}{t}$: $\frac{d}{t}$ $\frac{0}{2}$ $\frac{16}{4}$ = 4 m/s

c distance = 3 km

time = 6 min = $\frac{6}{60}$ hours = 0.1 hours

speed = $\frac{3}{0.1}$ = 3 km/h

Q7

The driver of a car travelling at 80 km/h turned a bend and saw a broken-down car ahead. He took 0.75 second to react, and after he braked the car travelled a further 39.2 metres before stopping. **Calculate** the total distance taken for the car to stop. (Hint: Convert the speed of the car into m/s.)

The driver is initially travelling at:

$$\frac{80}{3.6} = 22 \text{ m/s}$$

In taking 0.75 s to react, the car travels:

$22 \times 0.75 = 16$ m

The total distance the car takes to stop

= reaction distance + braking distance

= 16.5 + 39.2 = 55.7 m

Q8

Classify the following measuring errors as random or systematic.

a Finn always measures his height against the wall wearing his runners.

b Asha reads a thermometer scale from above.

c Shae miscounted the number of millimetres when measuring the length of an antenna.

d Carl times Min in a running race but his stopwatch takes 0.6 second to click off.

a Systematic error because the method of measuring has an inbuilt, constant sized error

b Random error due to parallax error in trying to read the scale from above

c Random error due to a miscount

d Systematic error due to a constant addition to the time that the stop watch will record for every measurement

Q9

Catarina is on yard duty collecting litter at school. She walks 300 m north, then 100 m west, finally turning to walk 300 m south. The journey takes 5 minutes.

a **State** the total distance travelled.

b **Calculate** Catarina's average speed in m/s.

c **Construct** a diagram of Catarina's journey.

d **State** her displacement.

e **Calculate** Catarina's average velocity.

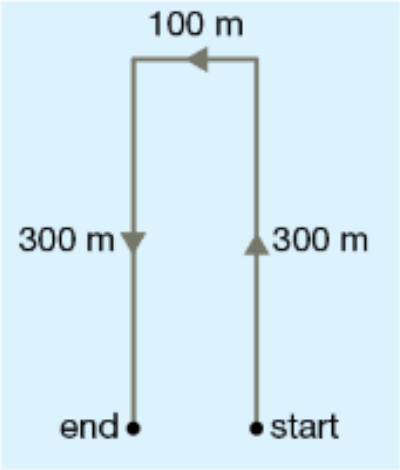
Q9 continued

a Catarina has travelled: 300 + 100 + 300 = 700 m

b Catarina's average speed (in m/s)

$$= \frac{d}{t} = \frac{700}{(5 \times 60)} = 2.3 \text{ m/s}$$

c



d Catarina's displacement is 100 m west.

e Catarina's average velocity

$$= \frac{\text{displacement}}{\text{time}} = \frac{100}{300} = 0.3 \text{ m/s west.}$$

Q10

A toy truck was stationary then rolls down a long ramp with a constant acceleration of $0.2\,m/s^2$. **Calculate** its speed after:

a 1 second
b 2 seconds
c 3 seconds
d 10 seconds.

a 0.2 m/s

b 0.4 m/s

c 0.6 m/s

d 2.0 m/s

Q11

John Strapp accelerated to a speed of 1017 km/h in 5 seconds and then came to a stop in 1 second. Convert this speed into m/s and **calculate** his:

a average acceleration in reaching 1017 km/h (in m/s^2)

b deceleration in coming to a stop (in m/s^2).

a John Strapp's speed = $\frac{1017}{3.6}$ = 282.5 m/s

His acceleration in reaching this final speed in 5 seconds is:

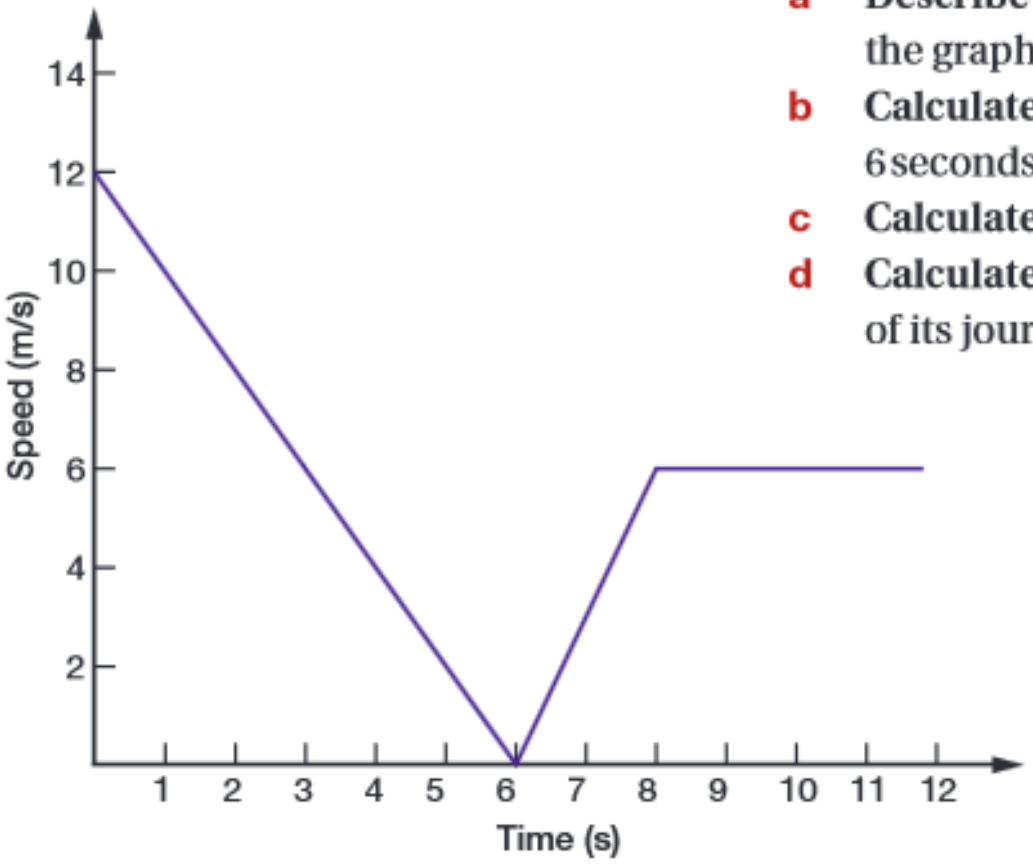
$$a = \frac{v - u}{t} = \frac{282.5}{5} = 56.5 \text{ m/s}^2$$

b His deceleration in coming to a stop is:

$$a = \frac{v - u}{t} = \frac{-282.5}{1} = -282.5 \text{ m/s}^2$$

Q12

illustrates the motion of a leaf floating in a running stream of water.



a **Describe** its motion over the 12 seconds shown on the graph.

b **Calculate** the acceleration of the leaf in the first 6 seconds.

c **Calculate** the distance it travelled in this time.

d **Calculate** its acceleration between 6 and 8 seconds of its journey.

Q12 continued

a The leaf is initially travelling quite fast, at 12 m/s. Its speed slows down until it stops for an instant at 6 seconds. Its speed increases over the next 2 seconds, so the leaf travels at 6 m/s. It continues at this constant speed for the rest of the time indicated on the graph.

b Acceleration of the leaf in the first 6 seconds:

$$a = \frac{v - u}{t} = \frac{0 - 12}{6} = -2 \text{ m/s}^2$$

c The distance it travelled in this time

= area below the speed–time graph

= ½ × 12 × 6= 36 m

d Acceleration between 6 and 8 seconds of its journey:

$$a = \frac{v - u}{t} = \frac{6 - 0}{2} = 3 \text{ m/s}^2$$