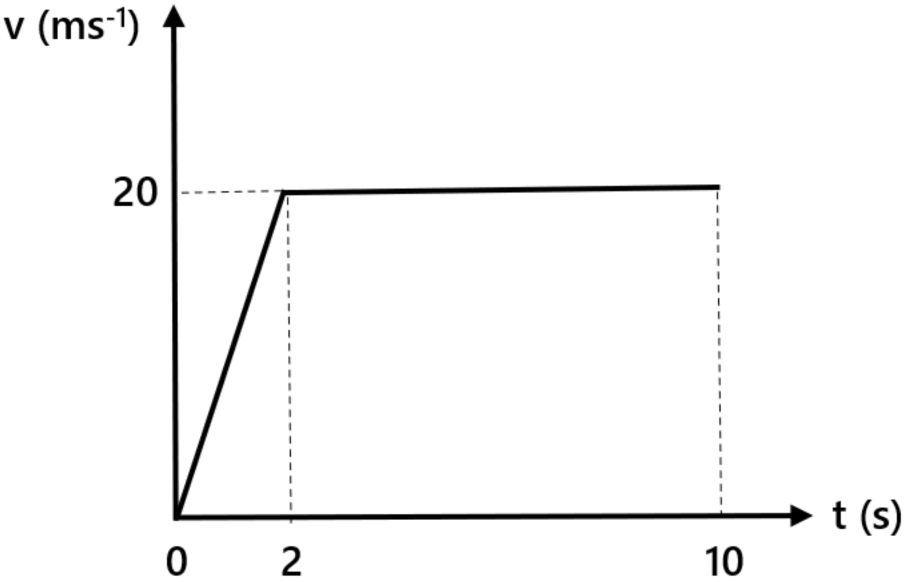
VELOCITY TIME GRAPHS

1) The speed time graph pictured below shows the journey of a car moving on a straight road for 10 seconds. The car begins from rest.



a. Work out the acceleration of the car for the first 2 seconds of the journey.
Passes through (0, 0) and (2, 20)

$$Acceleration = \frac{20-0}{2-0} = \mathbf{10\ ms^{-2}}$$

b. At what time does the car stop accelerating?
2 seconds

c. Work out the total distance travelled by the car.
Work out the area of the trapezium (area under the graph)
Height = 20
Parallel sides are 8 (10 – 2) and 10

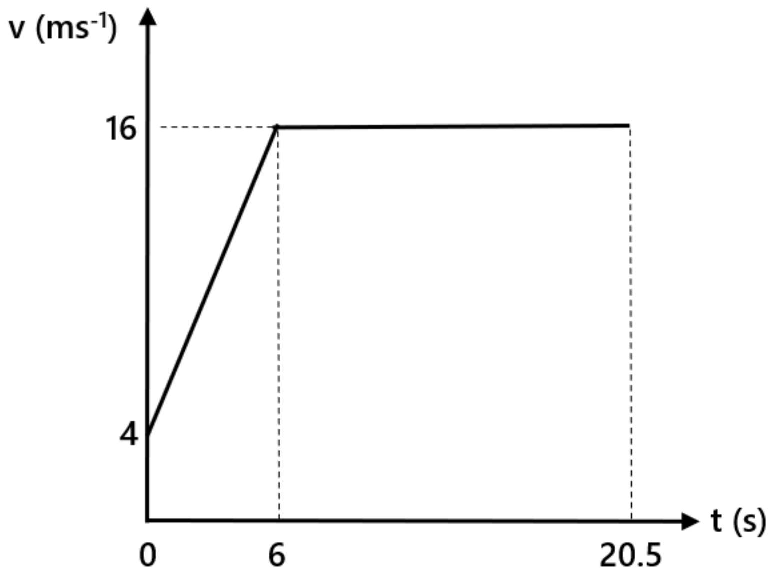
$$Distance = \frac{1}{2}(a+b)\times h$$

$$= \frac{1}{2}(8+10)\times 20$$

$$= \frac{1}{2}\times 18\times 20$$

$$= \mathbf{180\ metres}$$

2) The speed time graph shows the journey of a cyclist.



a. Work out the acceleration of the cyclist in the first 6 seconds.

Passes through (0, 4) and (6, 16)

$$Acceleration = \frac{16-4}{6-0} = \frac{12}{6} = \mathbf{2\ ms^{-2}}$$

b. Work out the total distance travelled by the cyclist.

Work out the area of the trapezium (area under the graph)

Height = 16

Parallel sides are 14.5 (20.5 – 6) and 20.5

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

$$= \frac{1}{2}(14.5 + 20.5) \times 16$$

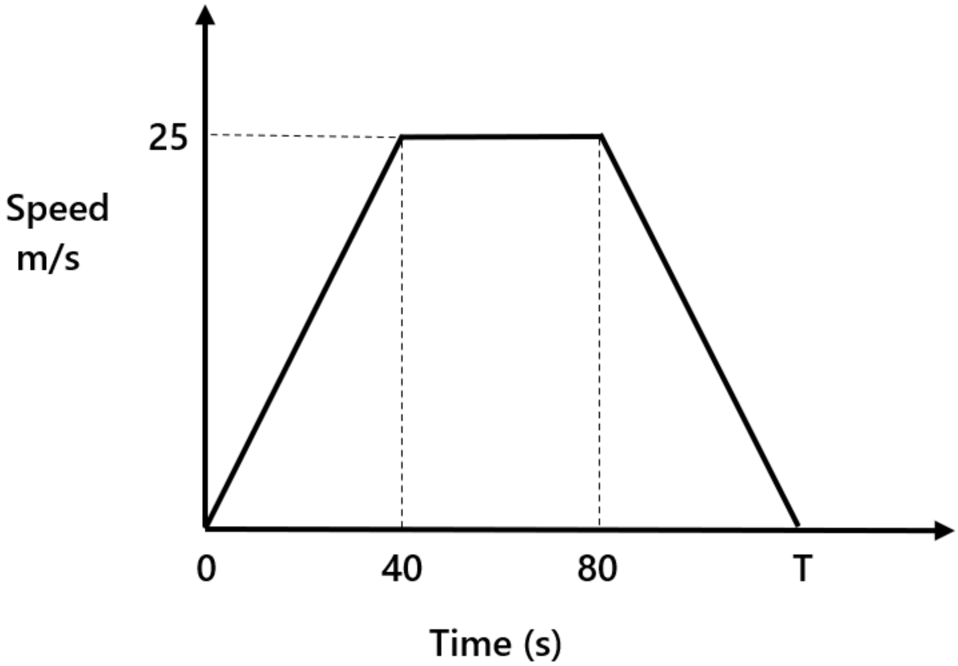
$$= \frac{1}{2} \times 35 \times 16$$

$$= \mathbf{280\ metres}$$

c. Convert the distance found in part b to kilometres.

$280 \div 1000 = \mathbf{0.28\ km}$

3) The speed time graph shows the journey of a train travelling between two stations.



a. Work out the acceleration of the train during the first 40 seconds of the journey.

Passes through (0, 0) and (40, 25)

$$Acceleration = \frac{25-0}{40-0} = \frac{25}{40} = \mathbf{0.625\ ms^{-2}}$$

b. Convert the speed 25 m/s to km/h.

$$25 \div 1000 = 0.025\ km/s$$

$$\frac{0.025}{1 \div (60 \times 60)} = \mathbf{90\ km/h}$$

c. Given that the train travelled 2 kilometres in total, work out the value of T.

Use the area of the trapezium to solve for T (area under the graph)

Height = 25

Parallel sides are 40 (80 – 40) and T

2 km = 2000 metres

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

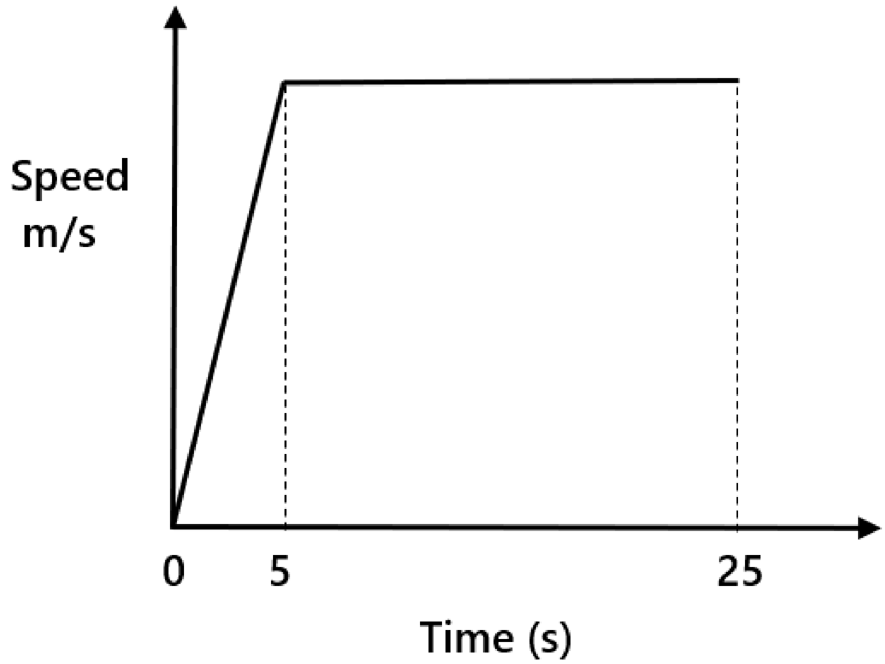
$$\frac{1}{2}(40+T) \times 25 = 2000$$

$$(40+T) \times 25 = 4000$$

$$40 + T = 160$$

$$T = \mathbf{120\ seconds}$$

4) The speed time graph shows a plane on a runway as it prepares for take-off.



a. At what time does the plane reach its maximum speed?
5 seconds

b. Given that the plane travels 2000 metres before take-off, work out the maximum speed of the plane on the runway. Give your answer to 3 significant figures.
Use the area of the trapezium to solve for the maximum speed (area under graph)
Height = h
Parallel sides are 20 (25 – 5) and 25

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

$$\frac{1}{2}(20 + 25) \times h = 2000$$

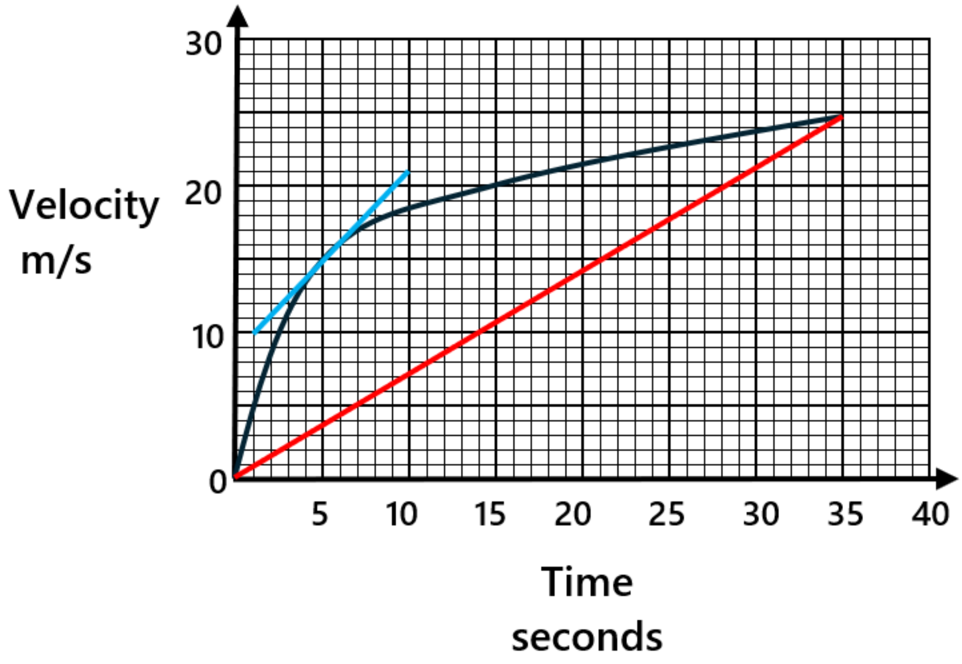
$$(20 + 25) \times h = 4000$$

$$45h = 4000$$

$$h = 88.888\ldots$$

Maximum speed = 88.9 m/s (3 sf)

5) The velocity time graph shows the speed of a truck as it enters a highway.



a. Is the truck accelerating or decelerating? Give a reason for your answer.
The truck is accelerating, as the graph slopes upwards.

b. Work out the average acceleration of the truck during the 35 seconds. Give your answer as an exact value.
Passes through the points (0, 0) and (35, 25)

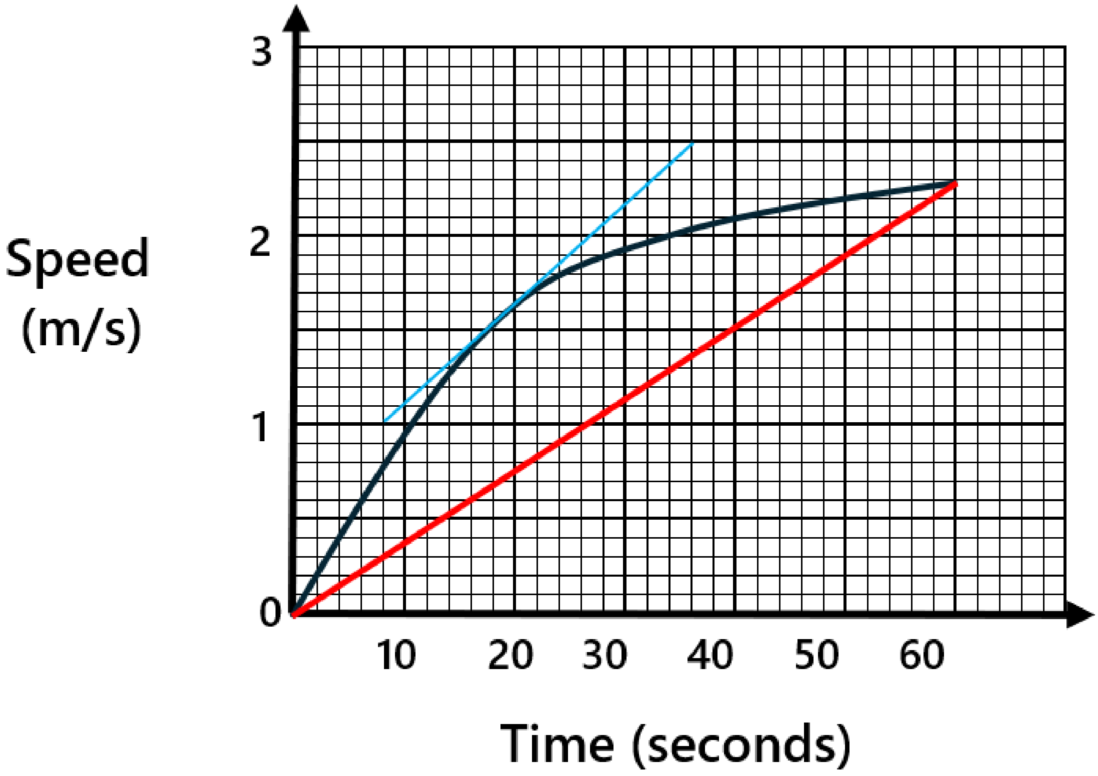
$$Acceleration = \frac{25-0}{35-0} = \mathbf{\frac{5}{7}}\ \boldsymbol{ms^{-2}}$$

c. Work out an estimate for the instantaneous acceleration at 5 seconds. Give your answer to 1 decimal place.
Tangent lines passes through (1, 10) and (10, 21)

$$Instantaneous\ acceleration = \frac{21-10}{10-1} = \frac{11}{9} = \mathbf{1.2}\ \boldsymbol{ms^{-2}}$$

[1.1 – 1.3 ms^{-2}]

6) The speed time graph shows the speed of a bug while it is in flight.



a. Work out the average acceleration of the bug during the first 60 seconds of flight. Give your answer to 3 decimal places.

Passes through the points (0, 0) and (60, 2.3)

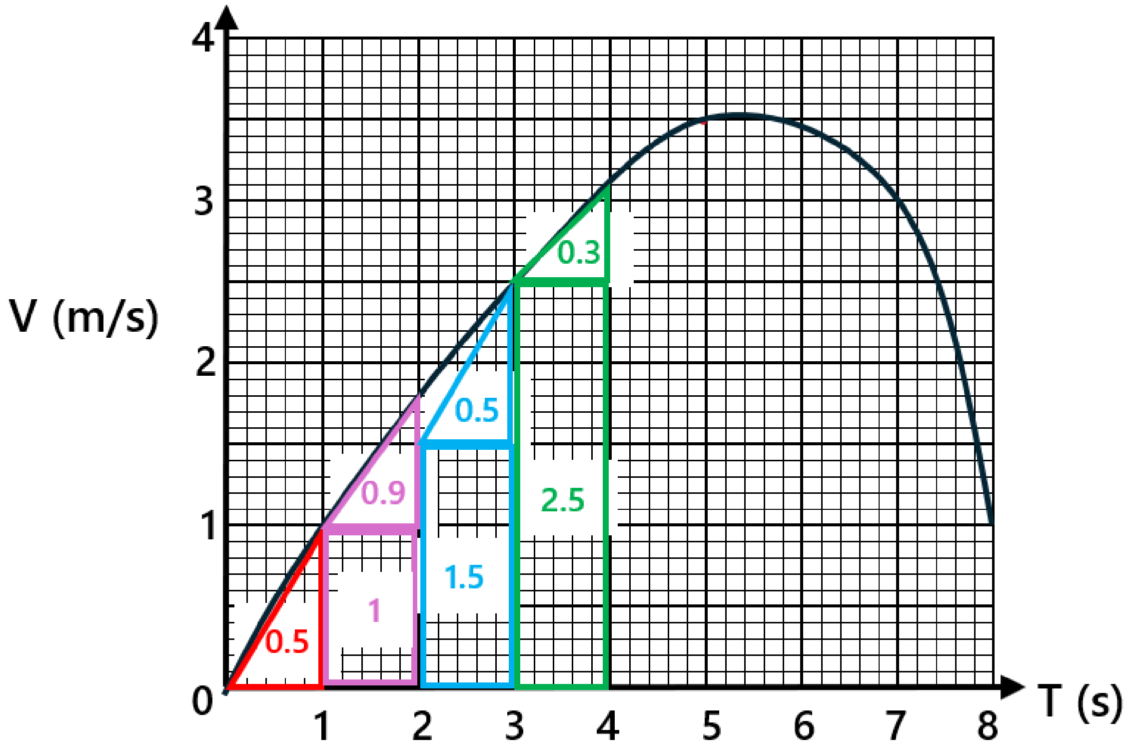
$$Acceleration = \frac{2.3 - 0}{60 - 0} = \frac{23}{600} = \mathbf{0.038\ ms^{-2}}\ (\mathbf{3\ dp})$$

b. Estimate the time during the 60 seconds of flight in which the average acceleration is equal to the instantaneous acceleration.

20 seconds

[18 – 21 seconds]

7) The velocity time graph of a particle is shown below.



a. Use four strips of equal width to estimate the distance travelled during the first four seconds.

Add the areas

0.5 + 0.9 + 1 + 0.5 + 1.5 + 0.3 + 2.5

= 7.2 metres

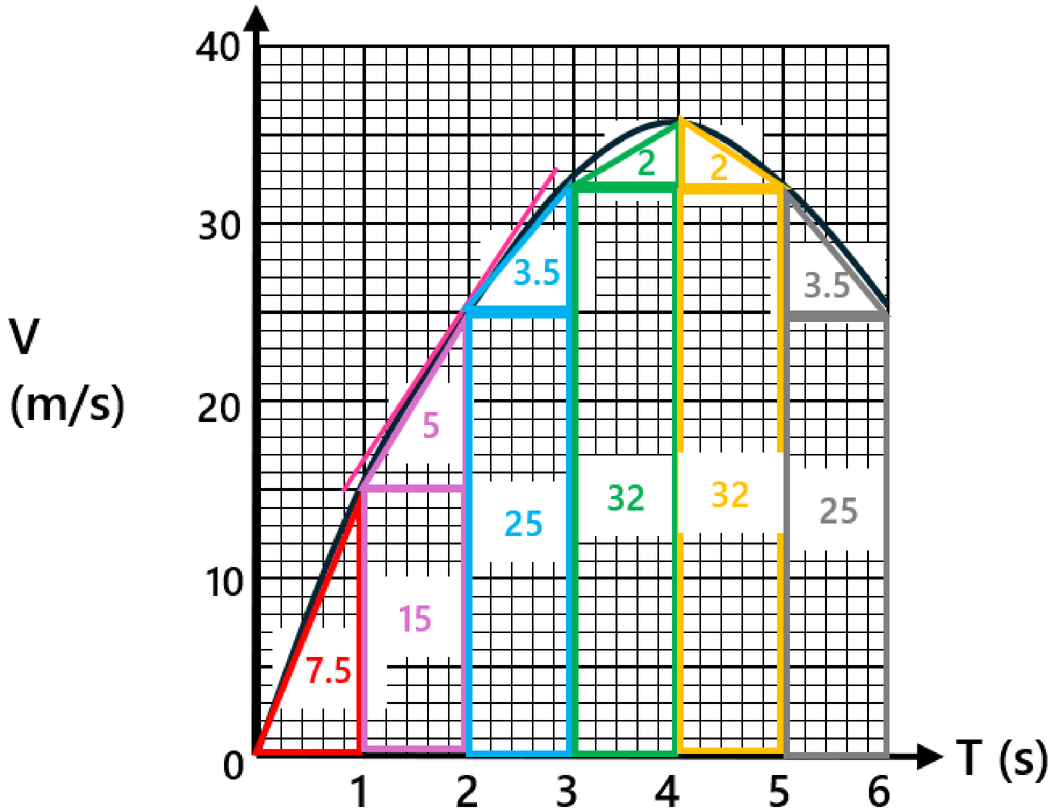
b. Is your answer to part a, an over or underestimate? Give a reason for your answer.

The answer is an underestimate – there is space underneath the curve between the triangles.

c. Explain how you can improve the accuracy of your estimation.

Increase the number of strips.

8) The velocity time graph for a ride at an amusement park is shown below.



a. Work out an estimate for the instantaneous acceleration of the ride at 2 seconds.

Tangent lines passes through (2.8, 33) and (0.8, 15)

$$Instantaneous\ acceleration = \frac{33-15}{2.8-0.8} = \frac{18}{1.6} = \mathbf{9}\ \boldsymbol{ms^{-2}}$$

[8.8 – 9.2 ms^2]

b. Use 6 strips of equal width to find an estimate for the area under the graph in the first 6 seconds of motion.

Add the areas

7.5 + 5 + 15 + 3.5 + 25 + 2 + 32 + 2 + 32 + 3.5 + 25

= 152.5 metres

c. Explain what your answer to part b represents.

The area under the graph represents the distance the ride travelled in the first 6 seconds of motion.