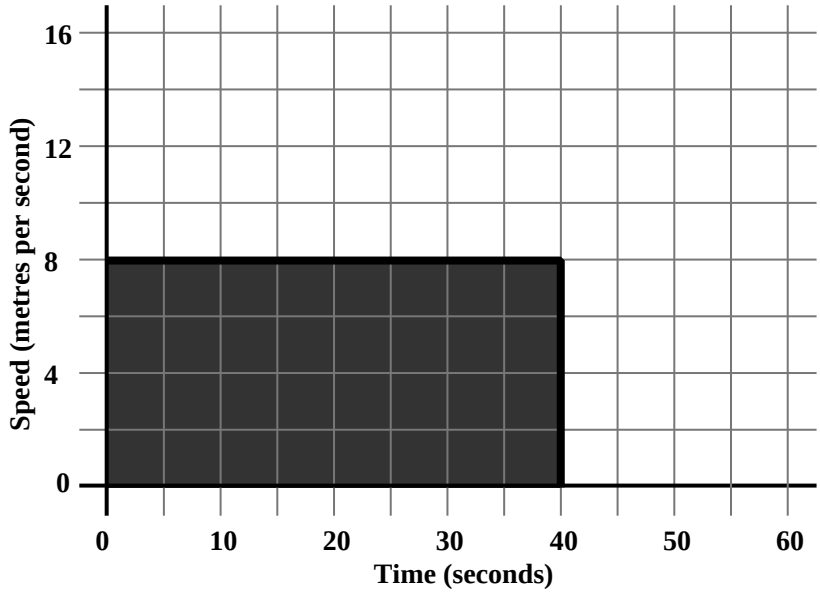
Lesson 4

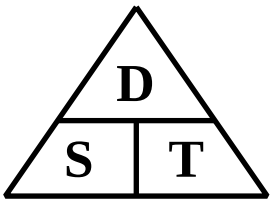
GCSE Mathematics
Kinematics

4.1 Speed - Time graphs

The Speed- Time graph shows a cyclist travelling at a steady speed of 8 m/s for a time of 40 seconds.



The distance travelled can be found using the Distance, Speed, Time formula triangle;



$$Distance = Speed \times Time$$

$$D = 8 \times 40$$

$$= 320\ m$$

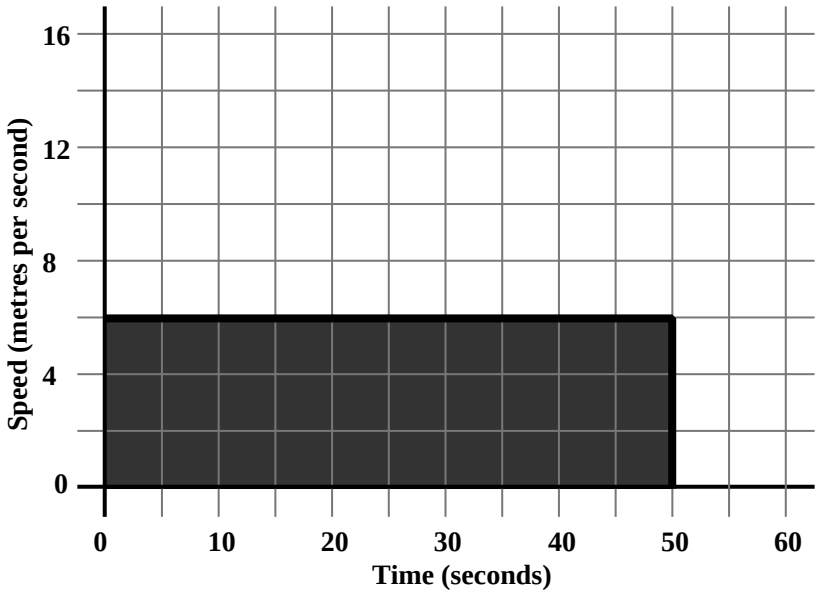
Alternatively, the distance can be found directly from the Speed - Time graph.

Can you see how ?

4.2 Exercise

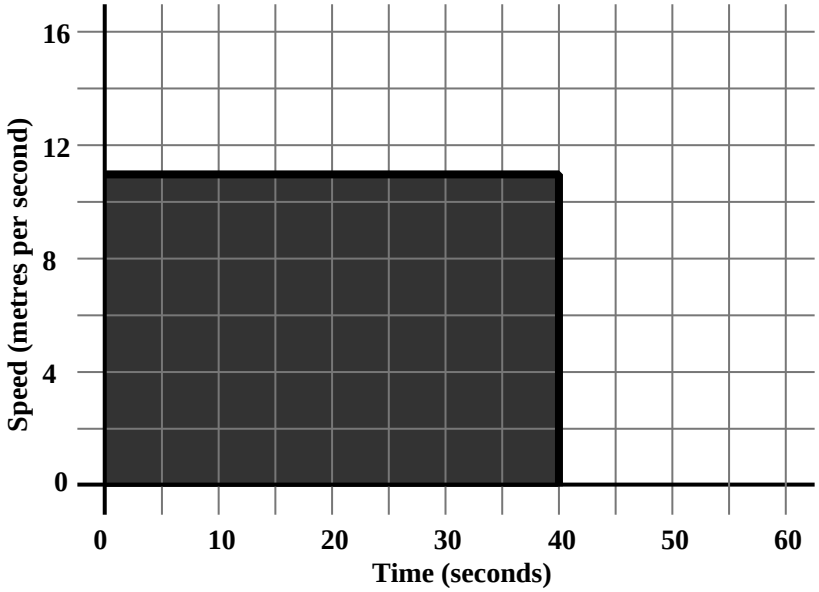
Take care with reading the deliberately awkward scales, especially on the y*-axis.*

Question 1



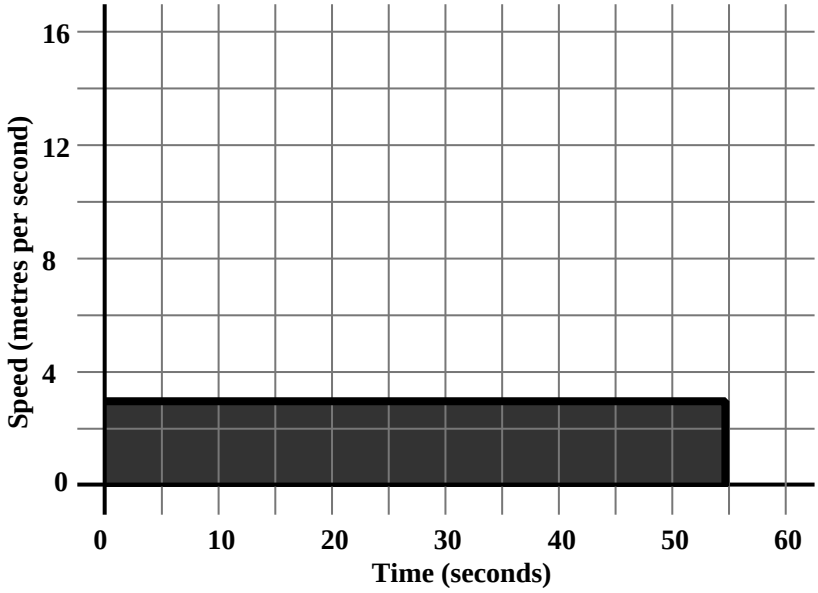
What distance is represented by the shaded region of this Speed - Time graph ?

Question 2



What distance is represented by the shaded region of this Speed - Time graph ?

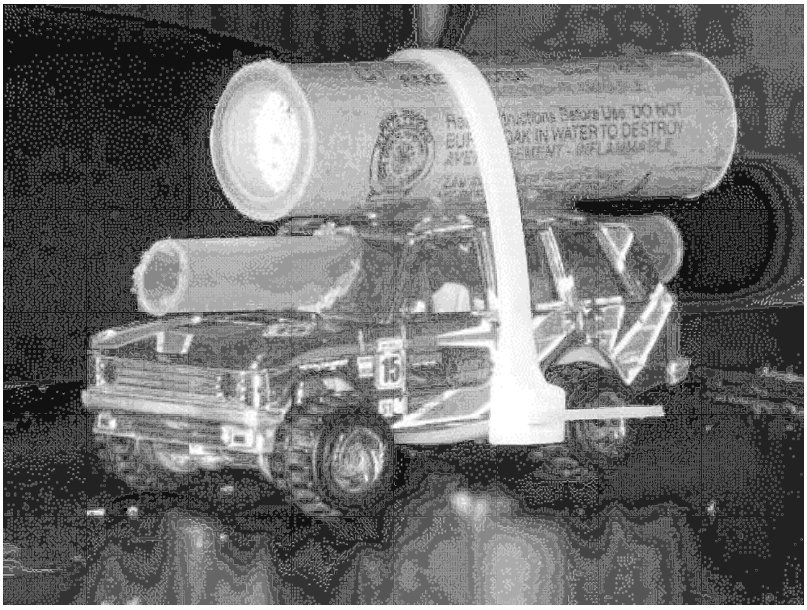
Question 3



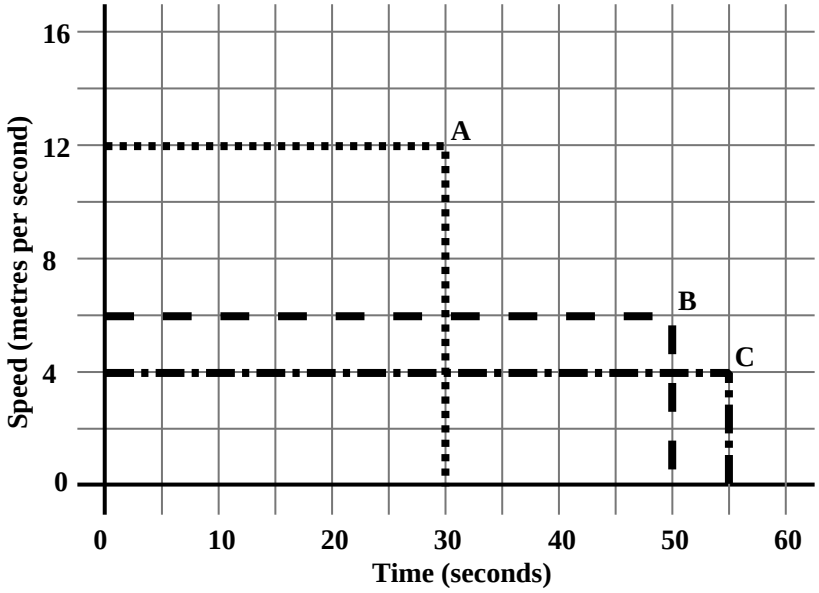
What distance is represented by the shaded region of this Speed - Time graph ?

Question 4

At a firework research facility, scientists are testing various 'rockets' by strapping them to toy cars to measure the time and intensity of the 'burn'.



The performance of three rockets, *A*, *B* and *C* are shown on the graph below.



(i) Which rocket had the longest burn time ?

(ii) Which rocket achieved the greatest speed ?

(iii) Which rocket powered a car along at 6 m/s ?

(iv) What is the 'burn distance' of rocket *A* ?

(v) What is the 'burn distance' of rocket *B* ?

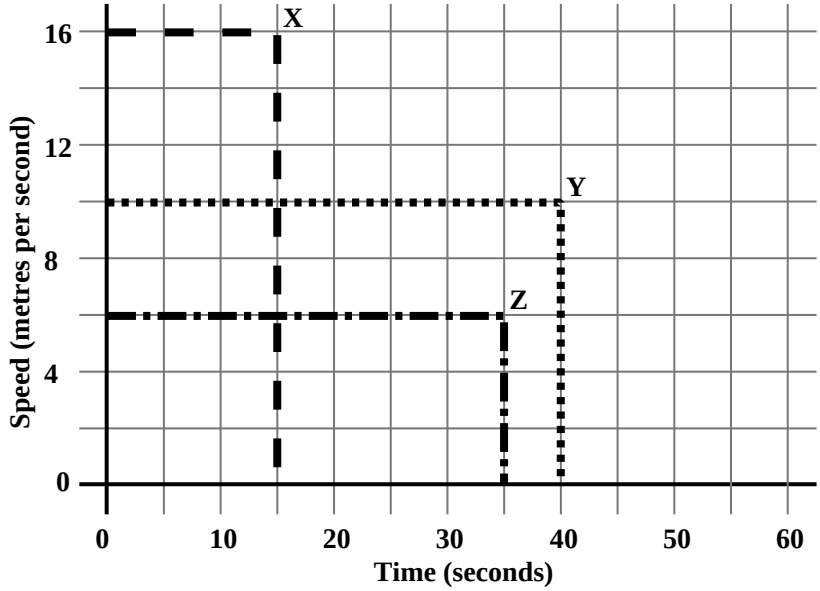
(vi) What is the 'burn distance' of rocket *C* ?

(vii) Which rocket had the largest 'burn distance' ?

(viii) A fourth rocket, *D*, is tested.
It powers the car along at a steady 10 m/s for 20 seconds.

Add the rocket *D* result to the Speed - Time graph.

Question 5



Three more rockets, *X*, *Y* and *Z* are tested.

(i) Which rocket had the longest burn time ?

(ii) Which rocket achieved the greatest speed ?

(iii) Which rocket powered a car along at 10 m/s ?

(iv) What is the 'burn distance' of rocket *X* ?

(v) What is the 'burn distance' of rocket *Y* ?

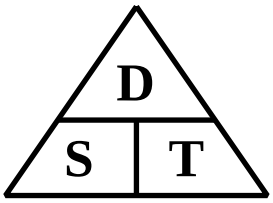
(vi) What is the 'burn distance' of rocket *Z* ?

(vii) Which rocket had the largest 'burn distance' ?

(viii) A fourth rocket, *W*, is tested.
It powers the car along at a steady 5 m/s for 60 seconds.
(*Be careful with that 5 m/s !*)
Add rocket *W* result to the Speed - Time graph.

Question 6

TRUE FOR ZERO ACCELERATION



Distance = Speed × Time

TRUE FOR ZERO ACCELERATION

With constant NON-ZERO acceleration: *Distance = Average Speed × Time*

(i) Find the average (the mean) of the following pairs of numbers;

(a) 23 and 37 **(b)** 15 and 71

(c) 5.5 and 8.5 **(d)** 0 and 44

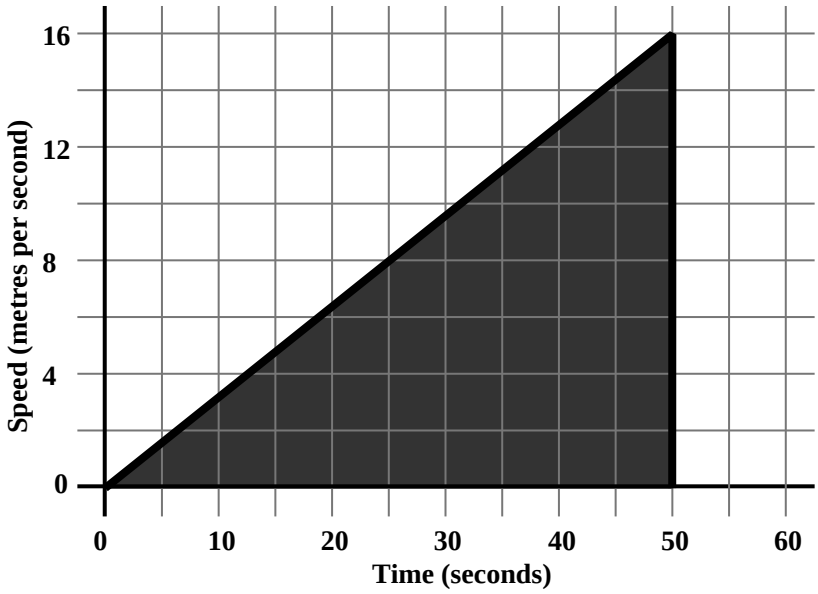
(ii) A train accelerates with such that it's speed increases uniformly from 0 m/s to 16 m/s over 50 seconds.

(a) What is the average (the mean) of 0 and 16 ?

(b) Find the distance the train moves whilst accelerating by using

Distance = Average Speed × Time

(c) Here is the train's Speed - Time graph.



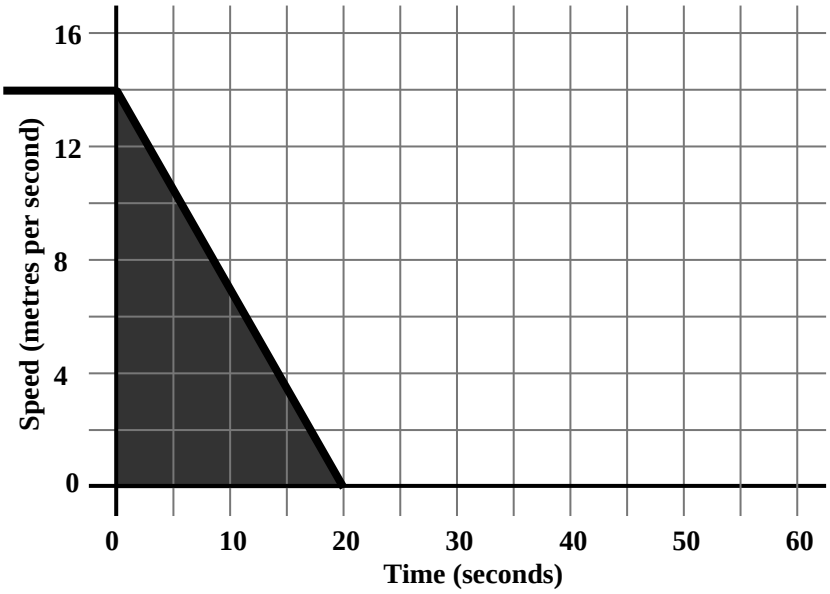
Find the area shaded using *Area* $\Delta = \frac{1}{2} \times base \times height$.

(d) Comment:

Question 7

A car is travelling along at a steady speed.
It then applies its brakes in order to stop for a Zebra Crossing †.

Here is the Speed - Time graph for the car.



(i) What was the speed of the car before the brakes were applied ?

(ii) How many seconds did it take for the car to stop ?

(iii) Work out the area of the shaded triangle.
(*This will be distance taken by the car to stop*)

(iv) Show how you would get the part **(iii)** answer by using the formula;

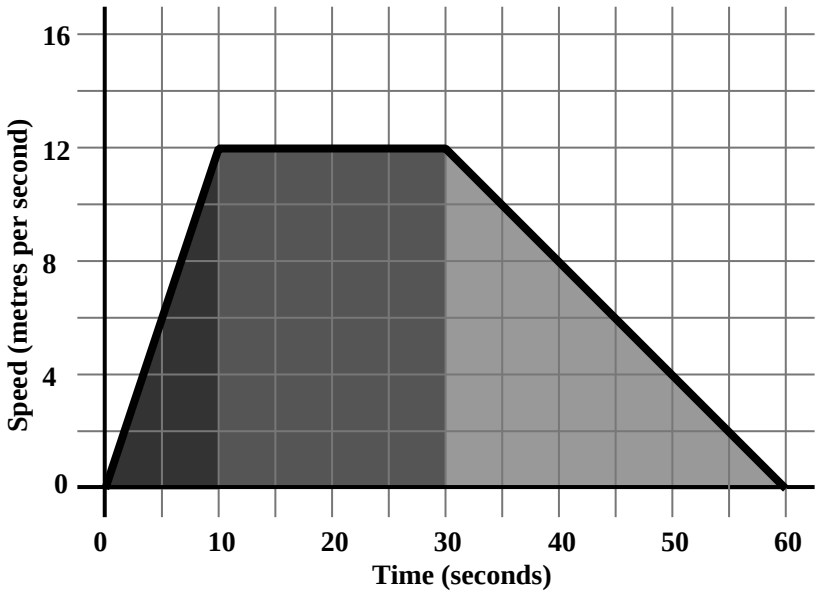
$$Distance = Average\ Speed \times Time$$

† It was not really a zebra crossing the road but a small girl carrying her dolly.

Question 8

A car is waiting at a red traffic light.
It turns green, and the car accelerates at a constant rate for 10 seconds.
The car then travels at 12 m/s for twenty seconds.
Finally, with another red light ahead the car decelerates and stops.

Here is a graph showing the car's speed and time as it moves between the red lights.



The distance between the two red traffic lights will be the area shaded.
One way of finding this, is to think of the area as being in three parts.

(i) Find the area of the acceleration triangle.
It has a base of 10 seconds and a height of 12 m/s.

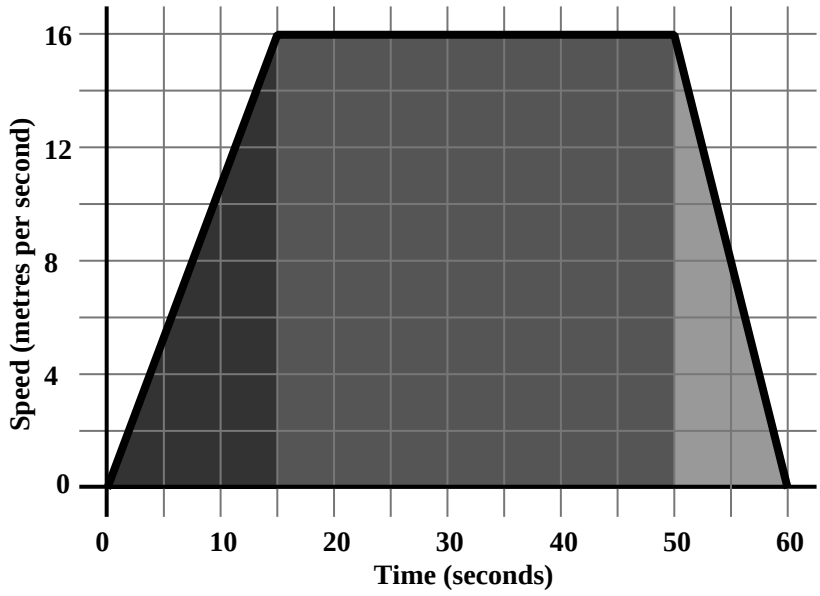
(ii) Find the area of the constant speed rectangle.
It has a length of 20 seconds and a height of 12 m/s.

(iii) Find the area of the deceleration triangle.
It has a base of 30 seconds and a height of 12 m/s.

(iv) Get the total distance by adding together answers **(i)**, **(ii)** and **(iii)**.

Question 9

Here is a graph showing a car's speed and time as it moves between traffic lights.



The distance between the traffic lights will be the area shaded.
One way of finding this, is to think of the area as being in three parts.

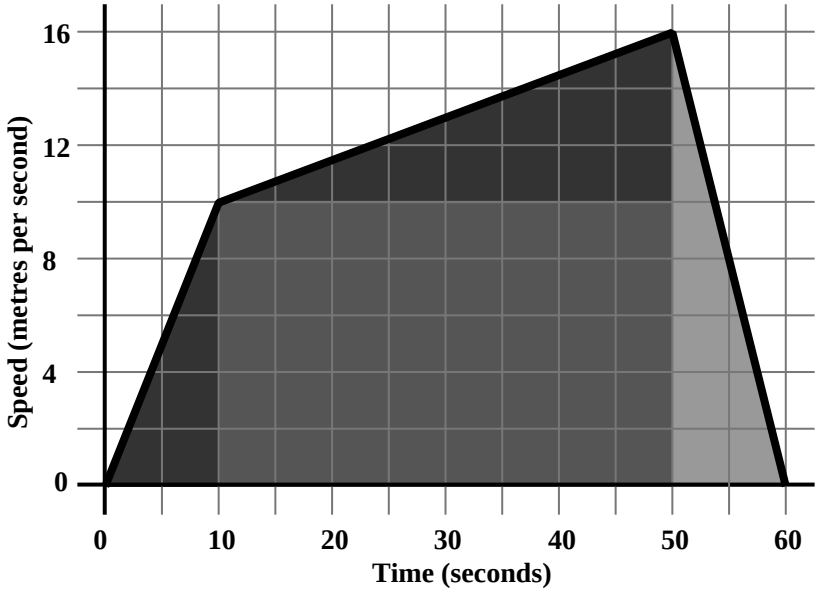
(i) Find the area of the acceleration triangle.

(ii) Find the area of the constant speed rectangle.

(iii) Find the area of the deceleration triangle.

(iv) Get the total distance by adding together answers **(i)**, **(ii)** and **(iii)**.

Question 10



Find the distance represented by the area on this Speed - Time graph.

You may wish to split the area into four bits to help you do this.