Speed, Distance & Time
Difficulty: Hard

Model Answers 1

Level	IGCSE
Subject	Maths (0580/0980)
Exam Board	CIE
Topic	Algebra & Graphs
Sub-Topic	Speed, Distance & Time
Paper	Paper 2
Difficulty	Hard
Booklet	Model Answers 1

Time allowed: **54 minutes**

Score: **/42**

Percentage: **/100**

Grade Boundaries:

CIE IGCSE Maths (0580)

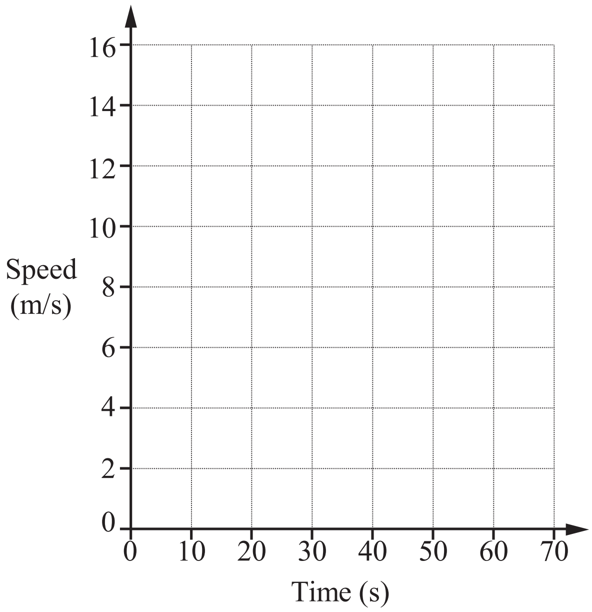
A*	A	B	C	D	E
>88%	76%	63%	51%	40%	30%

CIE IGCSE Maths (0980)

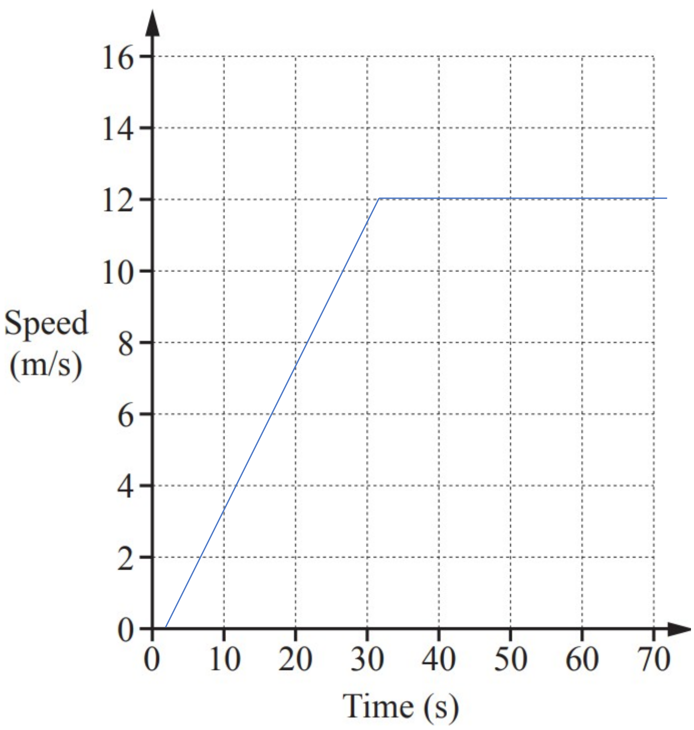
9	8	7	6	5	4	3
>94%	85%	77%	67%	57%	47%	35%

Petra begins a journey in her car.
She accelerates from rest at a constant rate of 0.4 m/s^2 for 30 seconds.
She then travels at a constant speed for 40 seconds.

On the grid, draw the speed-time graph for the first 70 seconds of Petra's journey.



[2]



Amar cycles at a speed of 18 km/h.
It takes him 55 minutes to cycle between two villages.

Calculate the distance between the two villages. [2]

Speed distance time relation is

$$\boldsymbol{speed = \frac{distance}{time}}$$

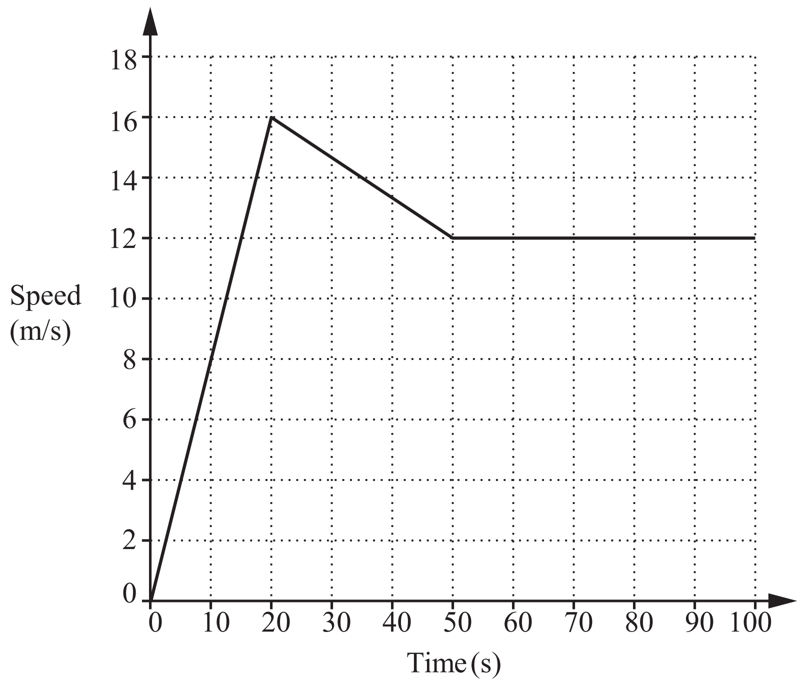
$$\rightarrow distance = time \times speed$$

Hence, converting time into hours

$$distance = \frac{55}{60} \times 18$$

$$= \mathbf{16.5}$$

The diagram shows information about the first 100 seconds of a car journey.



(a) Calculate the acceleration during the first 20 seconds of the journey. [1]

The acceleration is the gradient

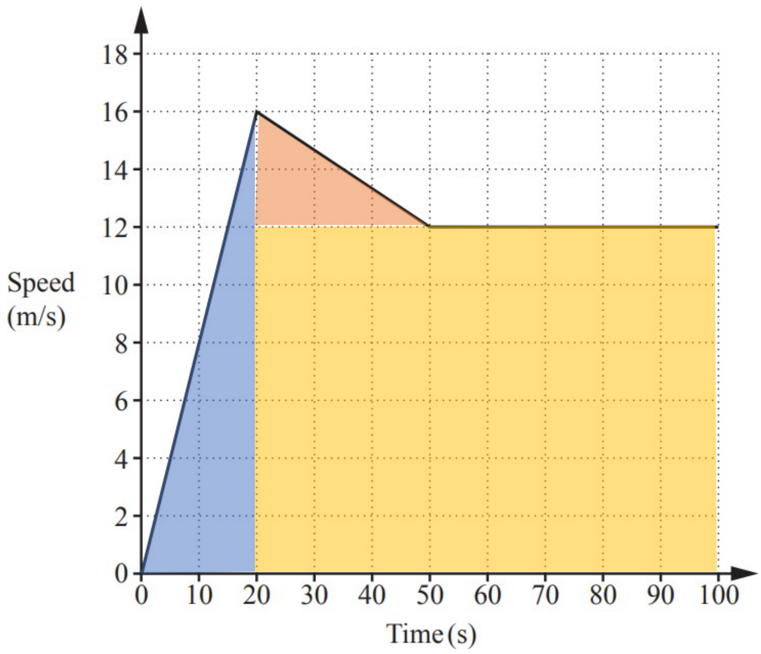
$$a = m = \frac{y_2 - y_1}{x_2 - x_1}$$

$$= \frac{16 - 0}{20 - 0}$$

$$= \mathbf{\frac{4}{5} = 0.8}$$

(b) Work out the total distance travelled by the car in the 100 seconds. [3]

The distance travelled is the area under the graph



We add the areas of the three shapes (drawn above)

$$A = \frac{1}{2} \times 20 \times 16 + \frac{1}{2} \times 4 \times 30 + 80 \times 12$$

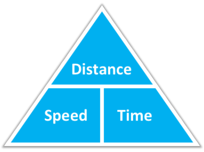
$$= \mathbf{1180}$$

Question 4

A train travels for m minutes at a speed of x metres per second.

(a) Find the distance travelled, in **kilometres**, in terms of m and x.
Give your answer in its simplest form.

[2]



Distance = Speed × Time

Distance $= x \times 60m$ metres

Multiply minutes by 60 to get seconds

Distance $= \dfrac{x \times 60m}{1000}$ kilometres

Divide metres by 1000 to get kilometres

And cancel: **Distance** $= \mathbf{\dfrac{3xm}{50}}$ **km**

(b) When $m = 5$, the train travels 10.5 km.

[2]

Find the value of x.

Substitute the values into the equation in (a):

$$10.5 = \frac{3 \times x \times 5}{50}$$

$$10.5 \times 50 = 15x$$

$$x = \frac{10.5 \times 50}{15}$$

$$\mathbf{x = 35 \text{ metres per second}}$$

A car of length 4.3 m is travelling at 105 km/h.
It passes over a bridge of length 36 m.

Calculate the time, in seconds, it takes to pass over the bridge **completely**. [3]

The car is on the bridge when its front is on the bridge and exits when its rear leaves.

The total distance to travel is therefore

$$36 + 4.3 = 40.3m$$

Converting the speed into m/s, first we multiply by 1000 to get the units in m/hr

$$Speed = 105\ kmh^{-1} \times 1000$$

$$Speed = 105000mh^{-1}$$

Next we have to turn it into m/s

$$Speed = 105000mh^{-1} \div (60^2)$$

$$Speed = \frac{105000}{3600}ms^{-1}$$

$$Speed = \frac{175}{6}ms^{-1}$$

Using the speed distance time relation

$$speed = \frac{distance}{time}$$

$$\frac{175}{6}ms^{-1} = \frac{40.3m}{time}$$

Rearrange for time

$$time = 40.3 \times \frac{6}{175}$$

$$= \underline{\mathbf{1.38}}\ s\ (2dp)$$

A car travels at 56km/h.

Find the time it takes to travel 300 metres.
Give your answer in seconds correct to the nearest second. [4]

First, we convert km/h to m/s.

$$56\ km/h = 56000\ m/h = \frac{56\ 000\ m/s}{3600\ seconds\ per\ hour} = 15.55\ m/s$$

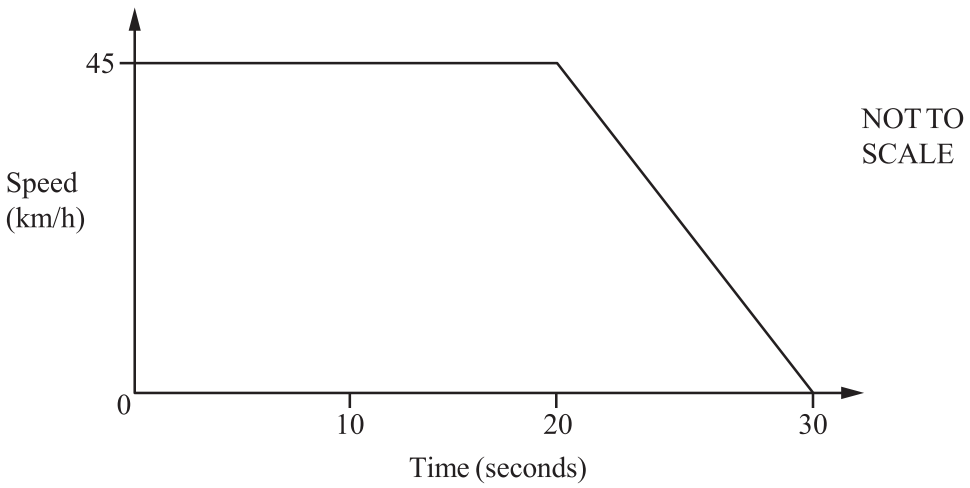
Then we calculate the time taken by dividing the distance travelled by the speed.

$$Time\ taken = \frac{distance}{speed} = \frac{300\ m}{15.55\ m/s}$$

$$Time\ taken = 19.3s$$

Round the answer to the nearest second.

$$Time\ taken = \mathbf{19s}$$



The diagram shows the speed-time graph of a car.
The car travels at 45 km/h for 20 seconds.
The car then decelerates for 10 seconds until it stops.

(a) Change 45 km/h into m/s. [2]

We convert km/h to m/s.

$$45\frac{km}{h} = 45000\frac{m}{h} = \frac{45\ 000\frac{m}{s}}{3600\ seconds\ per\ hour}$$

$$= \mathbf{12.5\ m/s}$$

(b) Find the deceleration of the car, giving your answer in m/s^2. [1]

The deceleration is defined as the change of velocity over the change of time.

The speed went from 12.5m/s to 0m/s, so the change of velocity was 12.5m/s.

This happened between 20second and 30 second since the measurement begun, so the change of time was 10 seconds.

$$deceleration = \frac{change\ of\ velocity}{changle\ of\ time} = \frac{12.5\ m/s}{10\ s}$$

$$= \mathbf{1.25\ ms^{-2}}$$

(c) Find the distance travelled by the car during the 30 seconds, giving your answer in metres. [3]

The total distance travelled by the car is the area under the graph.

To get the distance, we sum the rectangle and the triangle

(the area of a triangle is ½ times the product of two perpendicular sides).

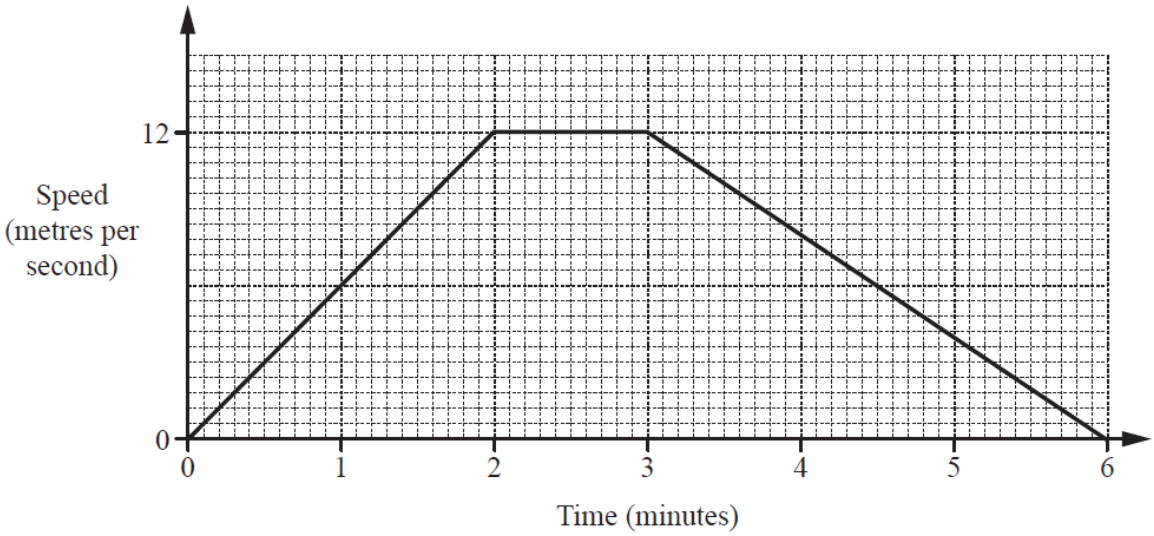
Use the speed in m/s we have calculated in part a).

$$distance = \ rectange + triangle$$

$$distance = 20s \times 12.5m/s + \frac{1}{2} \times (30s - 20s) \times 12.5m/s$$

$$distance$$

$$= \mathbf{312.5\ m}$$



A tram leaves a station and accelerates for 2 **minutes** until it reaches a speed of 12 metres per second.
It continues at this speed for 1 minute.
It then decelerates for 3 minutes until it stops at the next station.
The diagram shows the speed-time graph for this journey.

Calculate the distance, in metres, between the two stations. [3]

Distance travelled by the train is the area under the graph. To get the distance, we sum the two triangles and the rectangle.

(The area of a triangle is ½ times the product of two perpendicular sides)

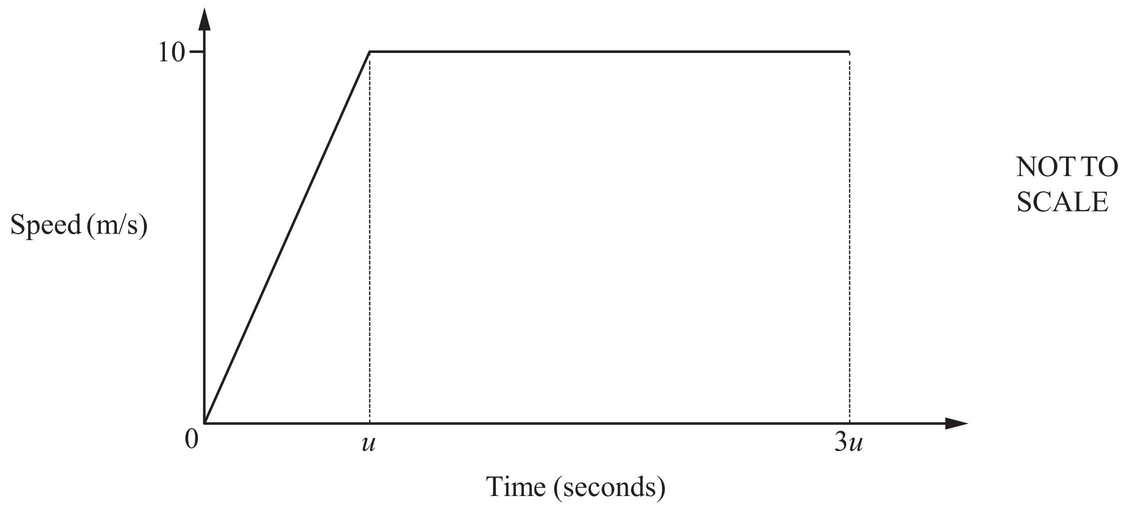
Convert minutes into seconds by multiplying by 60 (60 seconds per minute).

$$distance = first\ triangle + rectangle + second\ triangle$$

$$distance = \frac{1}{2} \times 120s \times 12m/s + (180 - 120)s \times 12m/s + \frac{1}{2} \times (360 - 180)s \times 12m/s$$

$$distance = 720m + 720m + 1080m$$

$$\boldsymbol{distance\ travelled = 2520m}$$



A car starts from rest and accelerates for u seconds until it reaches a speed of 10 m/s.
The car then travels at 10 m/s for $2u$ seconds.
The diagram shows the speed-time graph for this journey.

The distance travelled by the car in the first $3u$ seconds is 125 m.

(a) Find the value of u. [3]

The total distance travelled by the car is the area under the graph.

To get the distance, we sum the triangle and the rectangle

(the area of a triangle is ½ times the product of two perpendicular sides).

$$distance = triangle + rectangle$$

$$distance = \frac{1}{2} \times u \times 10m/s + 2u \times 10m/s$$

$$distance = (5u + 20u)m$$

We know that the distance travelled is 125m.

$$125m = (25u)m$$

Divide both sides of the equation by 25 to get the value of u.

$$u = \frac{125}{25}$$

$$\boldsymbol{u = 5}$$

(b) Find the acceleration in the first u seconds. [1]

The acceleration is defined as the change of velocity over the change of time

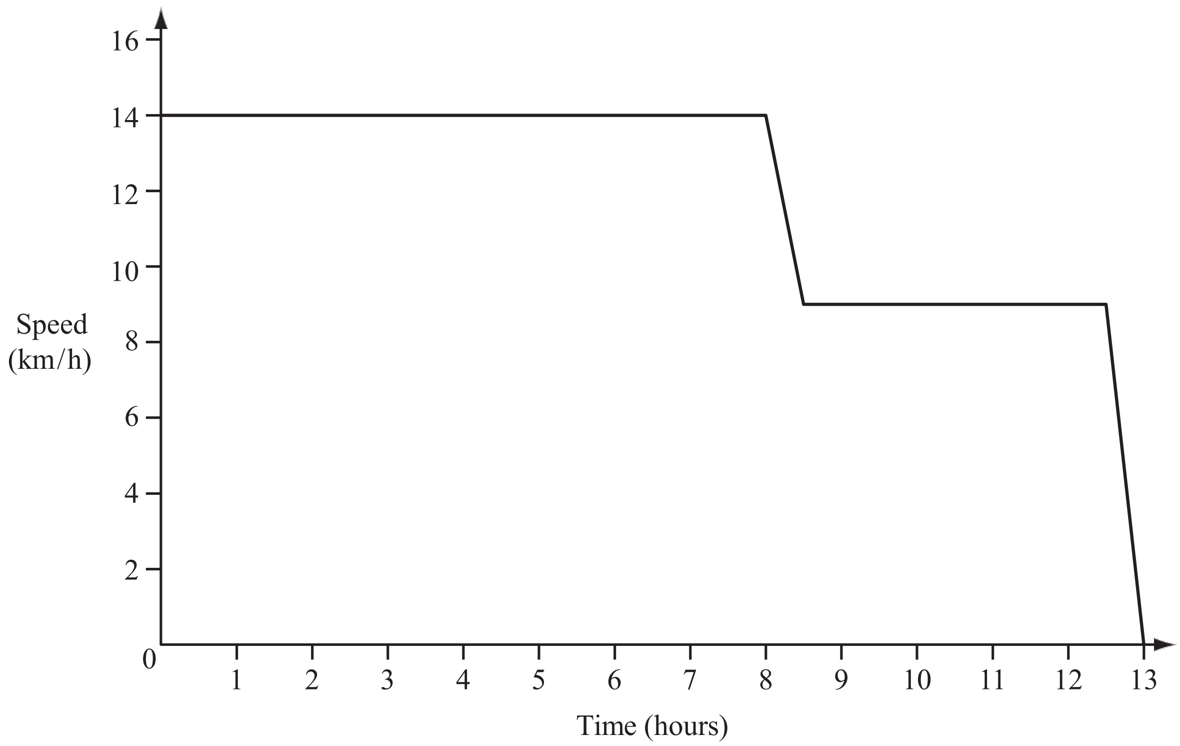
$$Acceleration = \frac{change\ of\ velocity}{changle\ of\ time} = \frac{10\ m/s}{5\ s}$$

$$= \mathbf{2\ ms^{-2}}$$

A container ship travelled at 14 km/h for 8 hours and then slowed down to 9 km/h over a period of 30 minutes.

It travelled at this speed for another 4 hours and then slowed to a stop over 30 minutes.

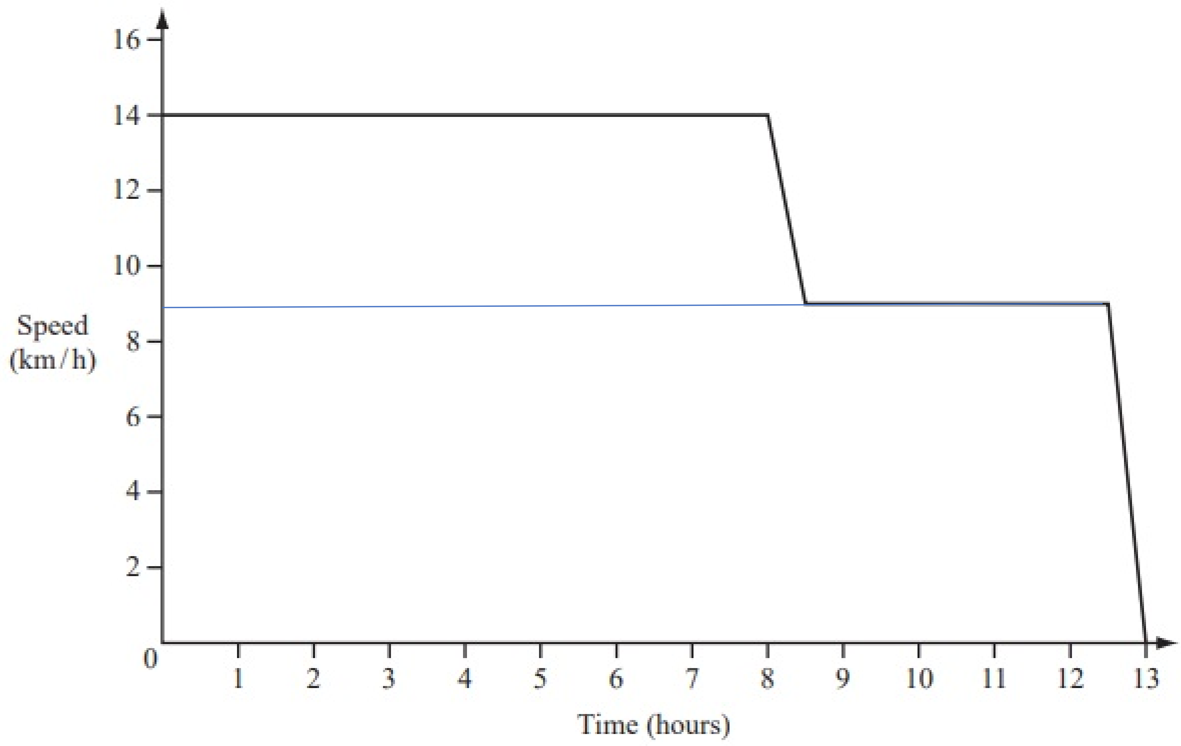
The speed-time graph shows this voyage.



(a) Calculate the total distance travelled by the ship. [4]

The area under the speed-time graph represents the distance travelled.

We separate the area under the graph in the 2 trapezia represented in the figure below to make the calculation easier.



The area of a trapezium is represented by the formula:

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

In our case, for the big trapezium, the height would be h =

9 km/h, and the 2 bases would be a = 12.5 hours and b =

13 hours

A = $\frac{(12.5\text{ h}+13\text{ h})\text{x } 9\text{ km/h}}{2}$

A = 114.75 km

For the small trapezium, h = 14 km/h – 9 km/h = 5 km/h

a = 8 hours, b = 8.5 hours

$A = \frac{(8.5\text{ h}+8\text{ h})\text{x } 5\text{ km/h}}{2}$

A = 41.25 km

Total area = A (big trapezium) + A (small trapezium)

Total area = 41.25 km + 114.75 km

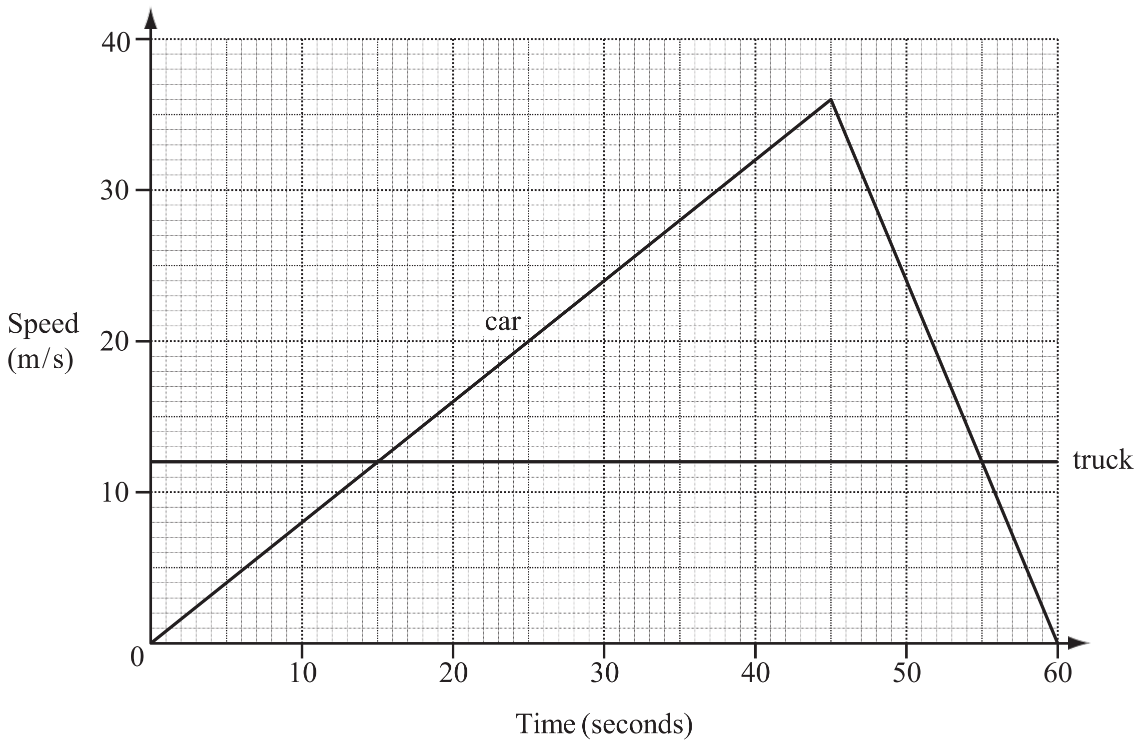
Total area = 156 km

(b) Calculate the average speed of the ship for the whole voyage. [1]

To work out the average speed we need to divide the total distance travelled by the total time taken to travel that distance.

Average speed = $\frac{156\text{ km}}{13\text{ hours}}$

Average speed = 12 km/h



The graph shows the speed of a truck and a car over 60 seconds.

(a) Calculate the acceleration of the car over the first 45 seconds. [2]

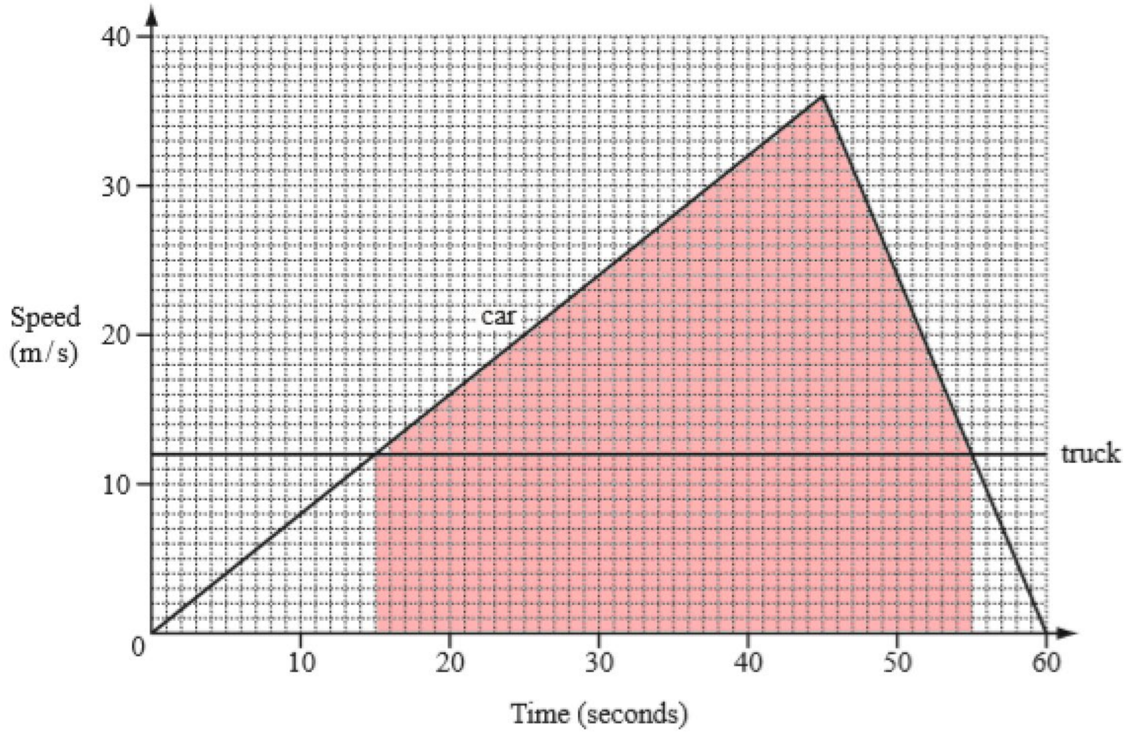
$Acceleration = \frac{Speed}{TIme}$. This is also the gradient of a speed time graph.

To calculate the acceleration over the first 45 seconds, we calculate the gradient for that part of the graph:

$$\boldsymbol{Acceleration \approx \frac{Change\ in\ y}{Change\ in\ x} = \frac{36}{45} = 0.8}$$

(b) Calculate the distance travelled by the car while it was travelling faster than the truck. [3]

The distance travelled can be found from a speed time graph as the area under the curve, and the distance travelled by the car while it was travelling faster than the truck is shown by the shaded area on the diagram below:



This area is calculated in two parts: Firstly the triangular part which can be calculated as follows

$$Area\ of\ triangle = \frac{1}{2} \times base\ \times height$$

$$Area\ of\ triangle = \frac{1}{2} \times 40\ \times 24 = 480$$

Secondly the area of the rectangle is calculated as follows:

$$Area\ of\ rectangle = width\ \times height$$

$$Area\ of\ rectangle = 40\ \times 12 = 480$$

The total area is then 960, which is the total distance travelled

Therefor the total distance travelled by the car while it is travelling faster than the truck is

960m