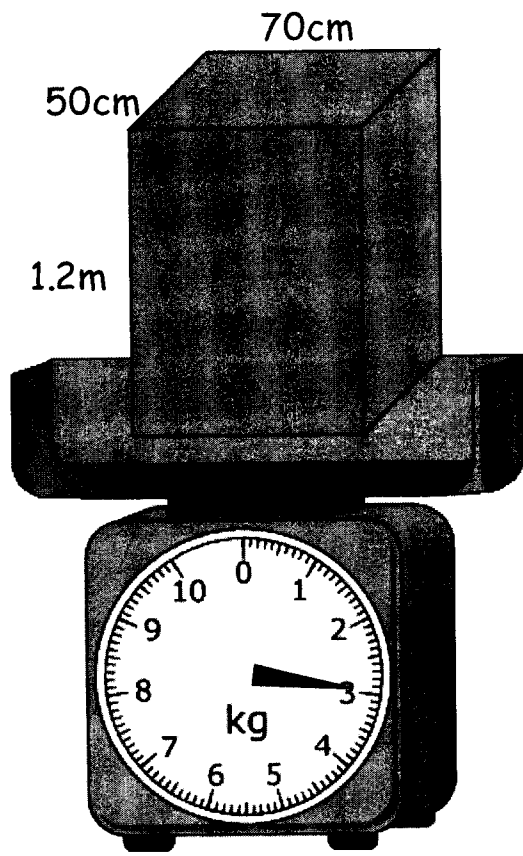


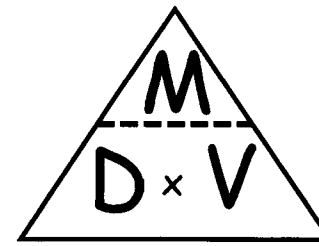
COMPOUND MEASURES

Page	Description
1	Introduction to Density
2	Further examples of density
3	Recap on density
4	Time. Converting from hours and minutes to decimals
5	Speed calculations
6	Speed problem
7	Distance time graphs
8	More distance time graphs
9	Distance time graphs and velocity time graphs
10	Converting between different units of speed
11	Interpreting graphs of rates including drawing tangents on curves
12	Population Density and Speed questions



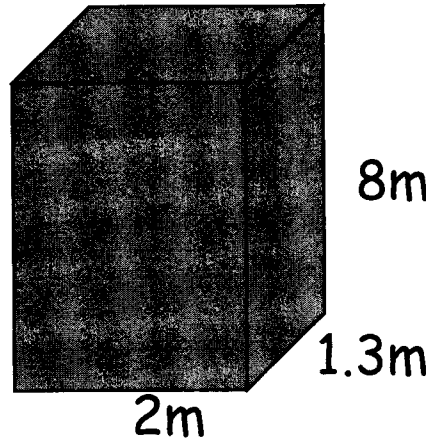
Density

$$\text{Density} = \frac{\text{mass}}{\text{volume}}$$



mass =

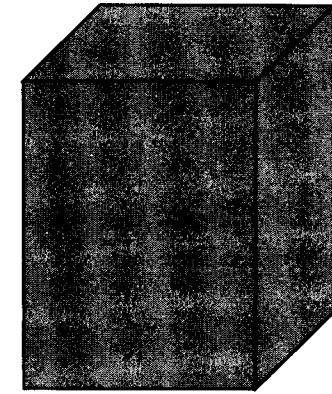
volume =



This block has a density of 5000 kg/m^3 .
How much does it weigh?

$$\text{Volume of block } 2 \times 1.3 \times 8 = 20.8 \text{ m}^3$$

$$\begin{aligned} \text{Mass} &= D \times v \\ &= 5000 \times 20.8 \\ &= 104000 \text{ kg} \end{aligned}$$



This block is made from a material with density 4000 kg/m^3 .

The weight of the block is 7500 kg .

What is the volume of the block?

$$\begin{aligned} V &= \frac{M}{D} \\ V &= \frac{7500}{4000} = 1.875 \text{ m}^3 \end{aligned}$$

What is the density of the material the block is made from?

$$\begin{aligned} \text{Volume of block in } \text{m}^3 \\ &= 1.2 \times 0.5 \times 0.7 = 0.42 \text{ m}^3 \end{aligned}$$

$$\text{Mass (from scales)} = 3 \text{ kg}$$

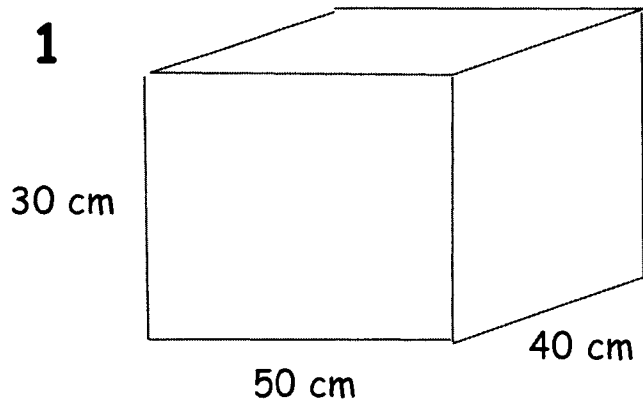
$$\text{Density} = \frac{M}{V} = \frac{3}{0.42} = 7.14 \text{ kg/m}^3$$

①

Calculate the missing quantity in each question.

Density = mass/volume
Mass = density x volume
Volume = mass/density

1

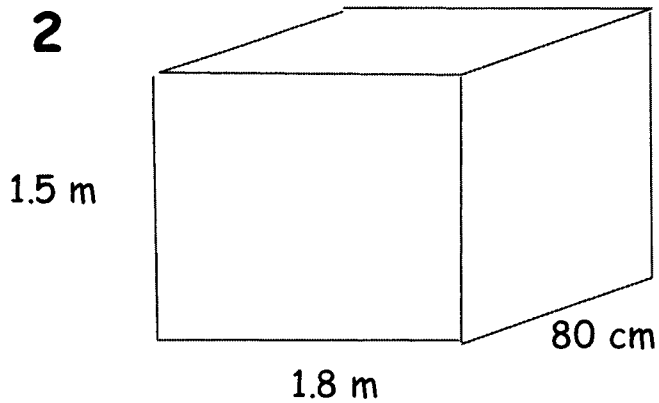


Calculate the volume of this block in m^3 .
The block weighs 474 kg. What is the density of the material it is made out of?

$$\text{Volume} = 0.3 \times 0.5 \times 0.4 = 0.06 m^3$$

$$D = \frac{M}{V} = \frac{474}{0.06} = 7900 \text{ kg}/m^3$$

2



Calculate the volume of this block in m^3 . $1.5 \times 1.8 \times 0.8 = 2.16 m^3$

The density of the material the block is made out of is $500 \text{ kg}/m^3$.

What is the weight of this block? $M = D \times V = 500 \times 2.16 = 1080 \text{ kg}$

3 A cuboid of material has a mass of 30kg. The density of the material the block is made from is $150 \text{ kg}/m^3$.

What is the volume of the block? $V = \frac{M}{D} = \frac{30}{150} = 0.2 m^3$

4 Questions 1 to 3 contain 3 blocks, they are made from steel, wood and polystyrene. Match the material to the question number.

Steel Q1

Wood Q2

Polystyrene Q3

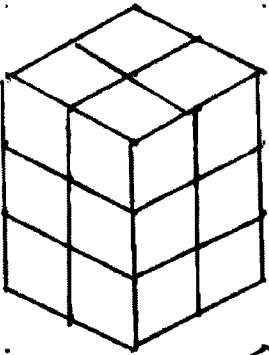
②

Density Each shape is a prism made from 1cm^3 cubes

The density of Iron = 7.8 g/cm^3 Aluminium = 2.7 g/cm^3 Gold 19.3 g/cm^3

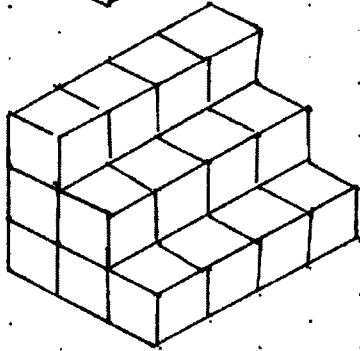
1) What is the weight of each of these prisms?

a) A Cuboid made of Gold



Volume
= 12cm^3
 $M = D \times V$
 $M = 19.3 \times 12$
= 231.6g

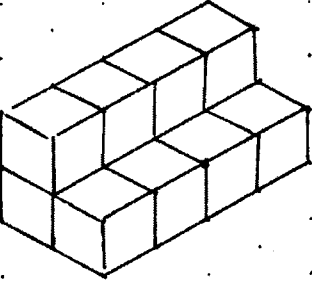
b) A Prism made of Aluminium



Volume = 24cm^3
 $M = D \times V$
= 2.7×24
= 64.8g

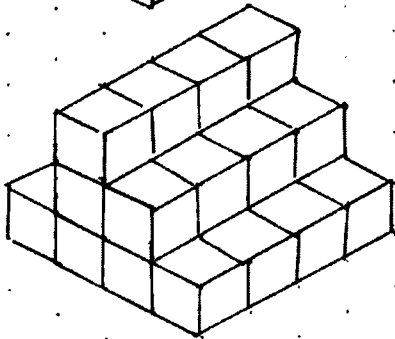
2) Which material is each prism made of?

a) Mass = 32.4 g



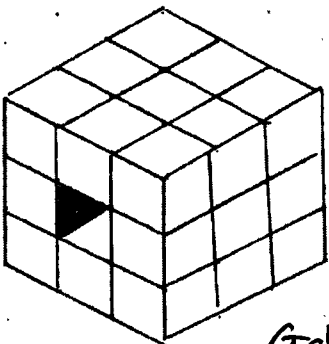
Volume
= 12cm^3
 $D = \frac{M}{V}$
= $\frac{32.4}{12}$
= 2.7 g/cm^3
Aluminium

b) Mass = 218.4 g



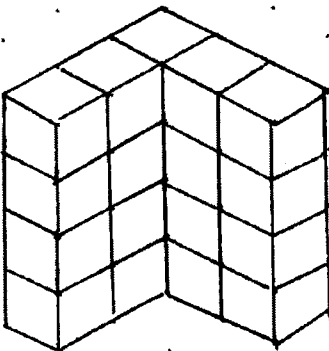
Volume 28cm^3
 $D = \frac{M}{V} = \frac{218.4}{28}$
= 7.8 g/cm^3
Iron

c) Mass = 463.2 g



$V = 24\text{cm}^3$
 $D = \frac{M}{V}$
= $\frac{463.2}{24}$
= 19.3 g/cm^3
Gold

d) Mass = 156 g



$V = 20\text{cm}^3$
 $D = \frac{M}{V} = \frac{156}{20}$
= 7.8 g/cm^3
Iron

3) Calculate the volume of each block. a) Block A is made of aluminium and weighs 135g .

$$V = \frac{M}{D} = \frac{135}{2.7} = 50\text{cm}^3$$

b) Block B is made of iron and weighs 234g . c) Block C is made of gold and weighs 386g .

$$V = \frac{M}{D} = \frac{234}{7.8} = 30\text{cm}^3$$

$$V = \frac{M}{D} = \frac{386}{19.3} = 20\text{cm}^3$$

③

Time conversion calculations

- 1) 2.5 hours = 2 hours 30 minutes $0.5 \times 60 = 30$
- 2) 1.2 hours = 1 hours 12 minutes $0.2 \times 60 = 12$
- 3) 0.7 hours = 0 hours 42 minutes $0.7 \times 60 = 42$
- 4) 3.12 hours = 3 hours 7.2 minutes $0.12 \times 60 = 7.2$
- 5) 4.8 hours = 4 hours 48 minutes $0.8 \times 60 = 48$
- 6) 3 hours 24 minutes = 3.4 hours $24 \div 60 = 0.4$
- 7) 4 hours 15 minutes = 4.25 hours $15 \div 60 = 0.25$
- 8) 1 hours 48 minutes = 1.8 hours $48 \div 60 = 0.8$
- 9) 1 hours 45 minutes = 1.75 hours $45 \div 60 = 0.75$
- 10) 2 hours 54 minutes = 2.9 hours $54 \div 60 = 0.9$

A car starts a journey at 3.12 pm. The journey finishes at 6.30 pm.

- 11) How long did the journey take in hours and minutes? 3h 18min
- 12) How long did the journey take as a decimal? 3.3 hrs $18 \div 60 = 0.3$

A car starts a journey at 4.22 pm. The journey finishes at 6.07 pm.

- 13) How long did the journey take in hours and minutes? 1h 45m
- 14) How long did the journey take as a decimal? 1.75 hrs $45 \div 60 = 0.75$

A car starts a journey at 1.56 pm. The journey finishes at 3.20 pm.

- 15) How long did the journey take in hours and minutes? 1h 24min
- 16) How long did the journey take as a decimal? 1.4 hrs $24 \div 60 = 0.4$

A car starts a journey at 1.56 pm and took 4 hours 15 minutes.

- 17) At what time did the journey finish? 6.11 pm
- 18) How long did the journey take as a decimal? 4.25 hrs $15 \div 60 = 0.25$

A car starts a journey at 3.47 pm. The journey took 3.35 hours. $0.35 \times 60 = 21$

- 19) How long did the journey take in hours and minutes? 3h 21min
- 20) At what time did the journey finish? 7.08 pm

Speed

1) A car sets off at 8.45 am and arrives at 10.09 am. It travels a distance of 84 miles.

a) How long does the journey take, in hours and minutes? $1\text{h } 24\text{min}$

b) How will you enter this time in hours on your calculator? 1.4

c) What is the average speed of the car for the journey? $S = \frac{D}{T} = \frac{84}{1.4} = 60\text{ mph}$

2) A car is travelling at 65 mph. It travels 143 miles.

a) How long does the journey take, in hours and minutes? $T = \frac{D}{S} = \frac{143}{65} = 2.2 = 2\text{h } 12\text{min}$
 $0.2 \times 60 = 12$

b) The car set off at 10.50 am. What time did arrive?

$$10:50\text{ am} + 2\text{h } 12\text{min} = 1:02\text{ pm}$$

3) A car is travelling at 40 mph. It set off at 7.55 am and arrives at 9.04 am.

a) How long does the journey take, in hours and minutes? $1\text{h } 9\text{min}$

b) How will you enter this time in hours on your calculator? 1.15 $9 \div 60 = 0.15$

c) What is the length of the journey? $D = S \times T = 40 \times 1.15 = 46\text{ miles}$

4) A train sets off at 8.45 am and arrives at 11.25 am. It travels a distance of 320 miles.

a) How long does the journey take, in hours and minutes? $2\text{h } 40\text{min}$ $40 \div 60 = 0.6$

b) How will you enter this time in hours on your calculator? 2.6 hours

c) What is the average speed of the train for the journey? $S = \frac{D}{T} = \frac{320}{2.6} = 120\text{ mph}$

5) A car is travelling at 40 mph. It travels 74 miles.

a) How long does the journey take, in hours and minutes? $T = \frac{D}{S} = 74 \div 40 = 1.85 = 1\text{h } 51\text{min}$
 $0.85 \times 60 = 51$

b) The car set arrived at 22:15. What time did it leave? Give your answer in am/pm time

$$22:15 - 1\text{h } 51\text{min} = 8:24\text{pm or } 20:24$$

6) A cyclist is travelling at 20 mph. They set off at 7.55 am and arrive at 5.40 pm.

a) How long does the journey take, in hours and minutes? $9\text{h } 45\text{min}$

b) How will you enter this time in hours on your calculator? 9.75 $45 \div 60 = 0.75$

c) What is the length of the journey? $D = S \times T$
 $= 20 \times 9.75 = 195\text{ miles}$

$$\text{Time} = \frac{\text{Distance}}{\text{Speed}}$$

Car travelling at 40 mph

	time taken	am/pm	24h
Newcastle	X	11 am	11:00
Leeds	$80 \div 40 = 2$	1 pm	13:00
Sheffield	$40 \div 40 = 1$	2 pm	14:00
Luton	$100 \div 40 = 2.5$	4:30 pm	16:30
London	$30 \div 40 = 0.75$	5:15 pm	17:15

Car travelling at 60 mph

	time taken	am/pm	24h
Newcastle	X	11 am	11:00
Leeds	$80 \div 60 = 1.3$	12:20 pm	12:20
Sheffield	$40 \div 60 = 0.6$	1 pm	13:00
Luton	$100 \div 60 = 1.6$	2:40 pm	14:40
London	$30 \div 60 = 0.5$	3:10 pm	15:10

Car travelling at 80 mph

	time taken	am/pm	24h
Newcastle	X	11 am	11:00
Leeds	$80 \div 80 = 1$	12 pm	12:00
Sheffield	$40 \div 80 = 0.5$	12:30 pm	12:30
Luton	$100 \div 80 = 1.25$	1:45 pm	13:45
London	$30 \div 80 = 0.375$	2:08 pm	14:08

$$0.375 = 23 \text{ mins}$$

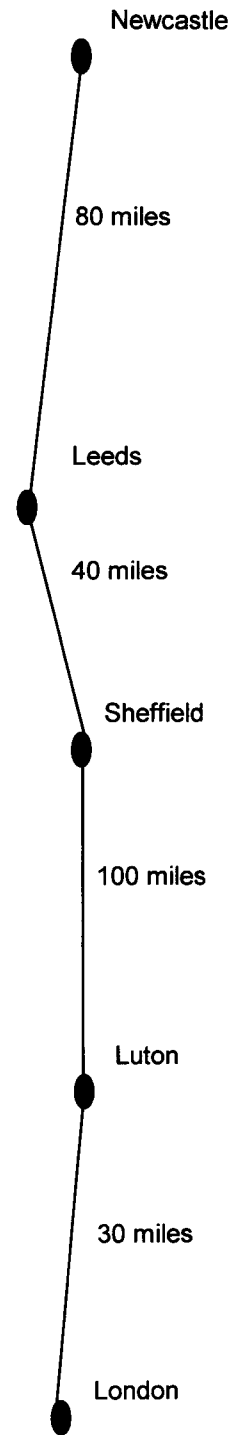
Time = distance ÷ speed

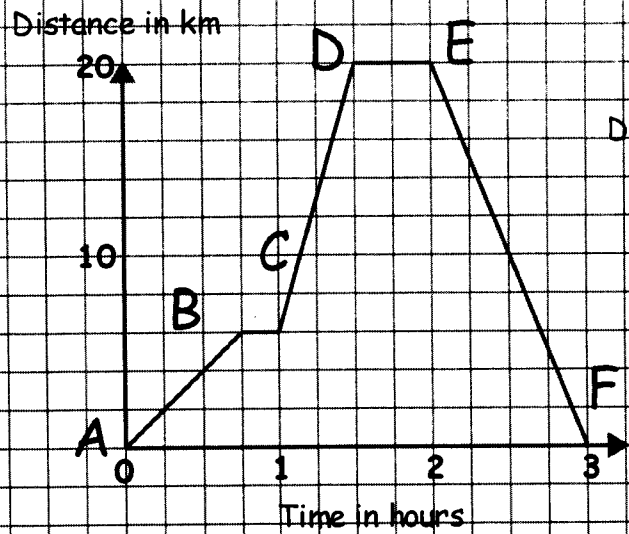
The car travelling at 80 mph is the first car to arrive at London.

How long is it before the other two cars arrive.

The 60 mph car. 1h 2m

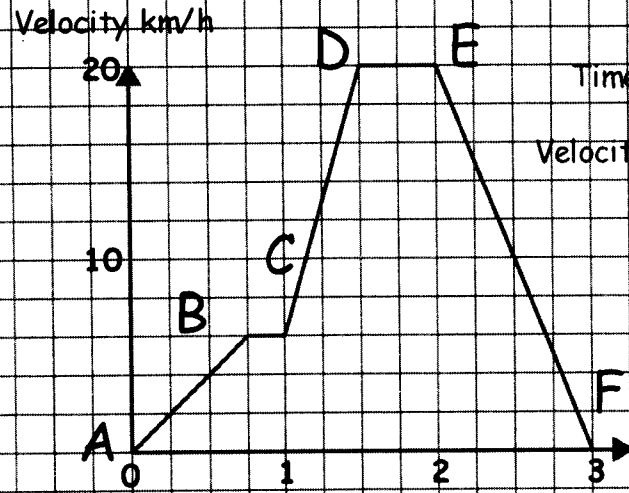
The 40 mph car. 3h 7m





Time	0	0.25	0.5	0.75	1	1.25	1.5	1.75	2	2.25	2.5	2.75	3
Distance	0	2	4	6	6	12	20	20	20	15	10	5	0

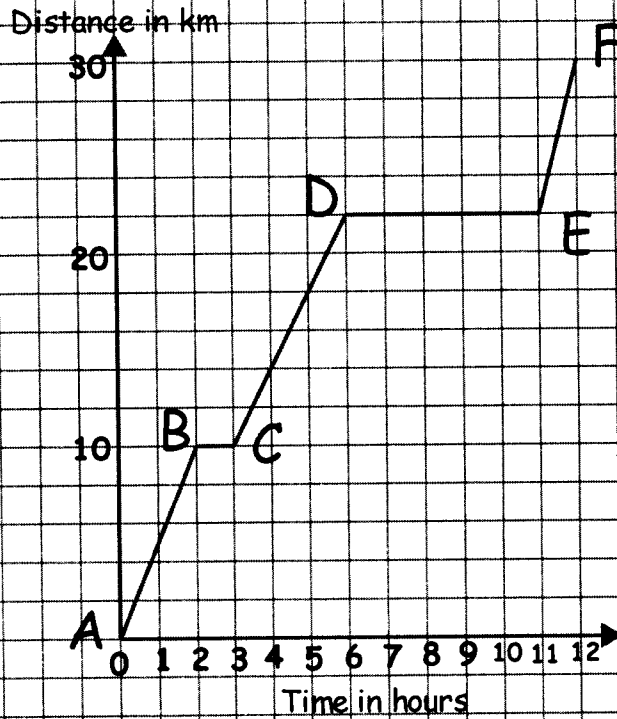
Section	Distance	Time	Velocity	Description
A to B	6	45 mins	$6 \div 0.75 = 8 \text{ km/h}$	
B to C	0	15 mins	0	
C to D	14	30 mins	$14 \div 0.5 = 28 \text{ km/h}$	
D to E	0	30 mins	0	
E to F	20	1	$20 \div 1 = 20 \text{ km/h}$	(speed = 20 km/h velocity = -20 km/h)



Time	0	0.25	0.5	0.75	1	1.25	1.5	1.75	2	2.25	2.5	2.75	3
Velocity	0	2	4	6	6	12	20	20	20	15	10	5	0

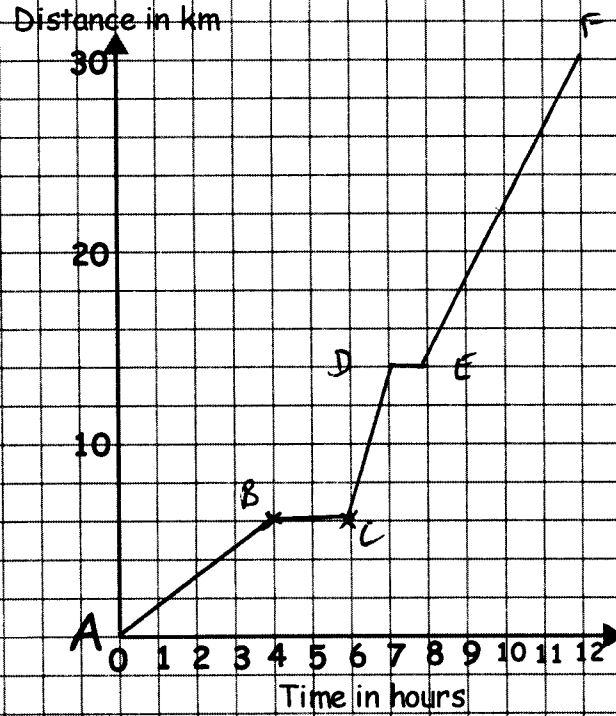
Section	Acceleration	Description
A to B	$6 \div 0.75 = 8 \text{ km/h}^2$	
B to C	0	
C to D	$14 \div 0.5 = 28 \text{ km/h}^2$	
D to E	0	
E to F	$20 \div 1 = 20 \text{ km/h}^2$	(technically -20 km/h ²)

1) Fill in the table from the graph



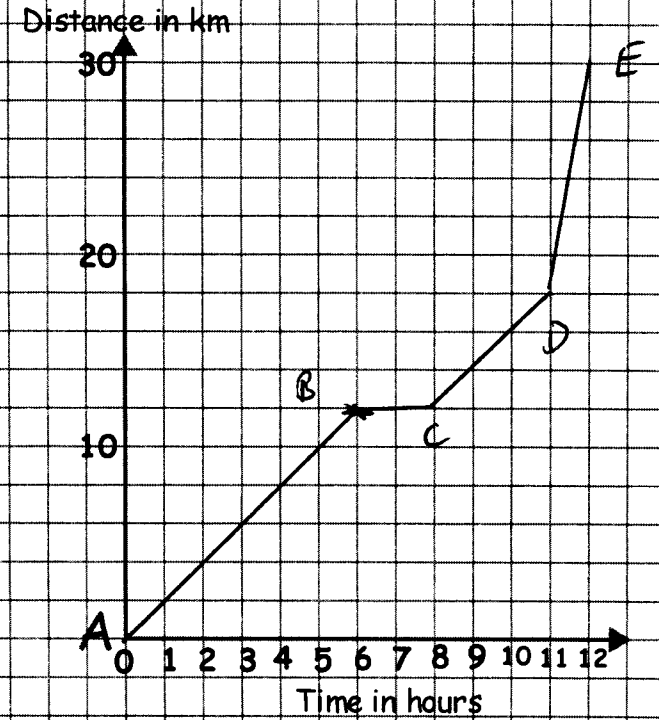
Section	Distance	Time	Speed
A to B	10	2	5
B to C	0	1	0
C to D	12	3	4
D to E	0	5	0
E to F	8	1	8

2) Fill in the graph from the table
Complete the table

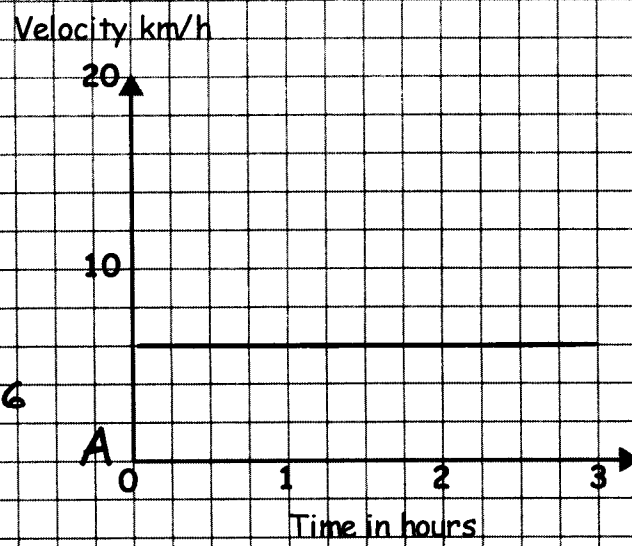
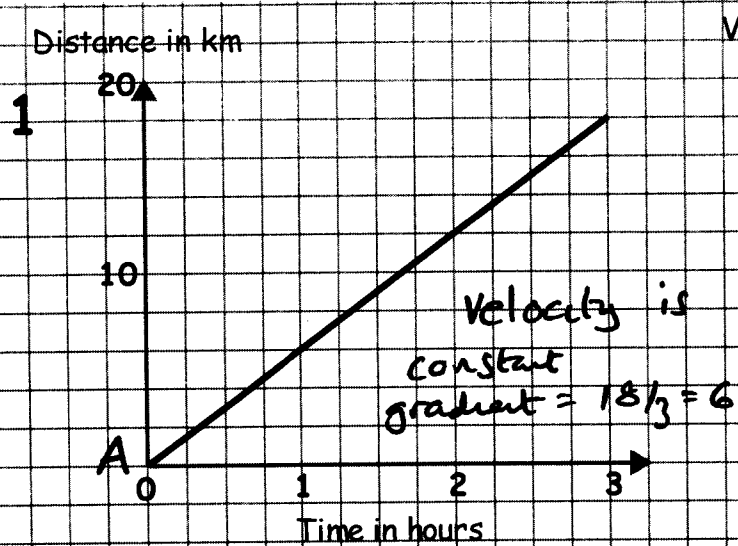


Section	Distance	Time	Speed
A to B	6 km	4 hours	1.5
B to C	0 km	2 hours	0
C to D	8 km	1 hour	8
D to E	0 km	1 hour	0
E to F	16 km	4 hours	4

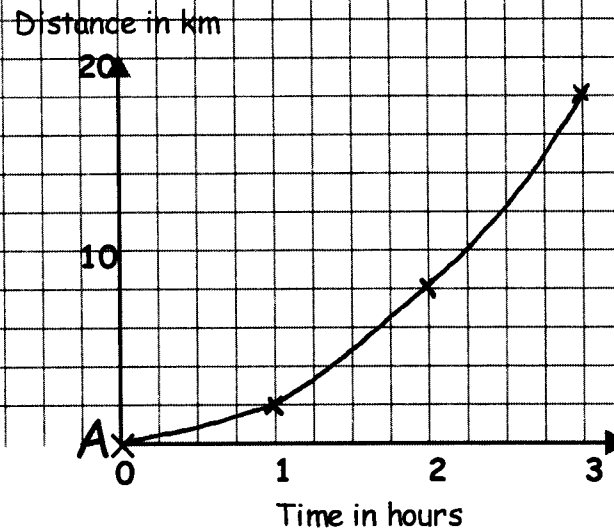
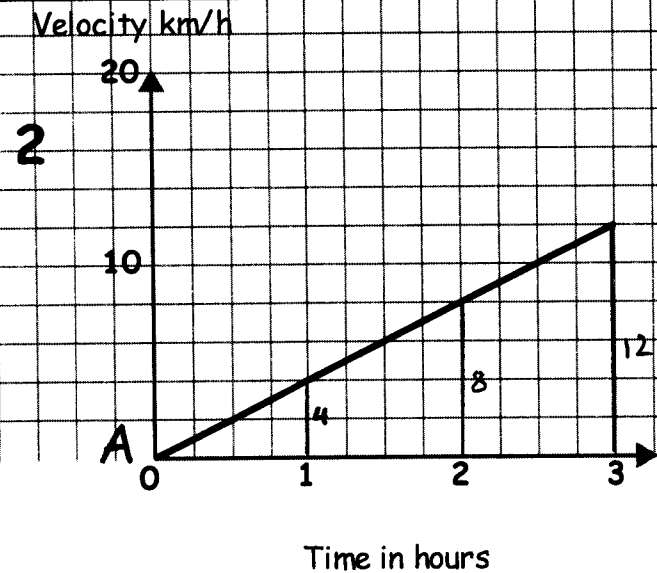
3) Fill in the graph from the table
Complete the table



Section	Distance	Time	Speed
A to B	12 km	6 hours	2
B to C	0 km	2 hours	0
C to D	6 km	3 hours	2
D to E	12 km	1 hour	12



Complete the velocity time graph by using the distance time graph.



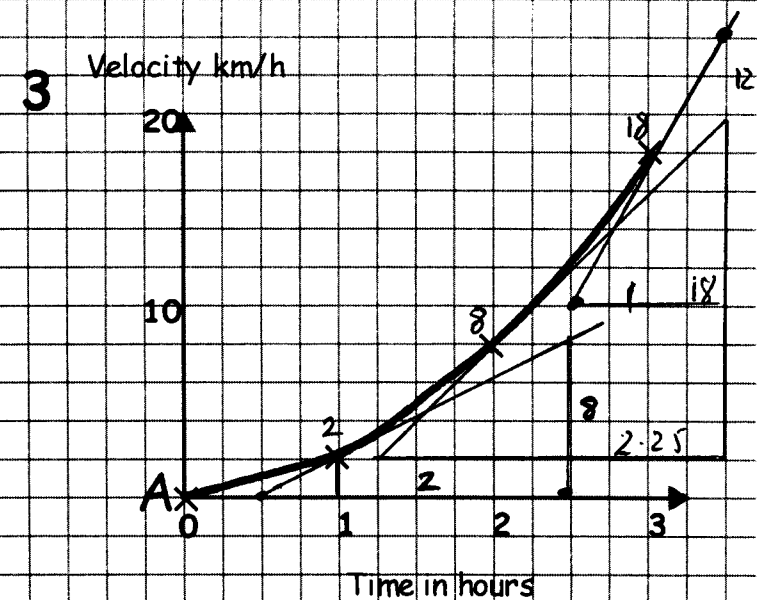
Complete the distance time graph by using the velocity time graph.

distance = area under graph
Area of triangles $\frac{1 \times 4}{2} = 2$

$$\frac{8 \times 2}{2} = 8$$

⑨

$$\frac{12 \times 3}{2} = 18$$



Complete the two tables by using the velocity time graph

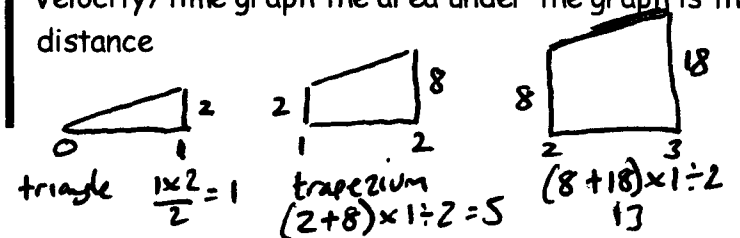
Time (hours)	0	1	2	3
Acceleration (km/h ²) gradients of tangents	0	$\frac{8}{2} = 4$	$\frac{18-8}{2-1} = 8$	$\frac{12-18}{1-2} = 12$
Time (hours)	0	1	2	3
Distance (km) area under graph see below	0	$\frac{1 \times 2}{2}$	4+5	4+5+13
		↓	6	19

Remember

Distance/time graph the gradient is the velocity

Velocity/time graph the gradient is the acceleration

Velocity/time graph the area under the graph is the distance



1 km = 1000 m

1 hour = 60 minutes = 3600 seconds

Converting from m/s to km/h

30 m/s means 30 metres in 1 second.

In 1 minute this would be 1800 m. 30×60

In 1 hour this would be 108000 m. 1800×60

In 1 hour this would be 108 km.

So 30 m/s is 108 km/h.

Converting from km/h to m/s

72 km/h means 72 km in 1 hour.

In 1 hour this would be 72000 m. 72×1000

In 1 minute this would be 1200 m. $72000 \div 60$

In 1 second this would be 20 m. $1200 \div 60$

So 72 km/h is 20 m/s.

Converting from mph to m/s

1 mile is 1.61 km

1 km = 1000 m

30 mph means 30 miles in 1 hour.

30 miles is 48.3 km, is 48300 m $30 \times 1.61 = 48.3 \text{ km}$

In 1 hour this would be 48300 m.

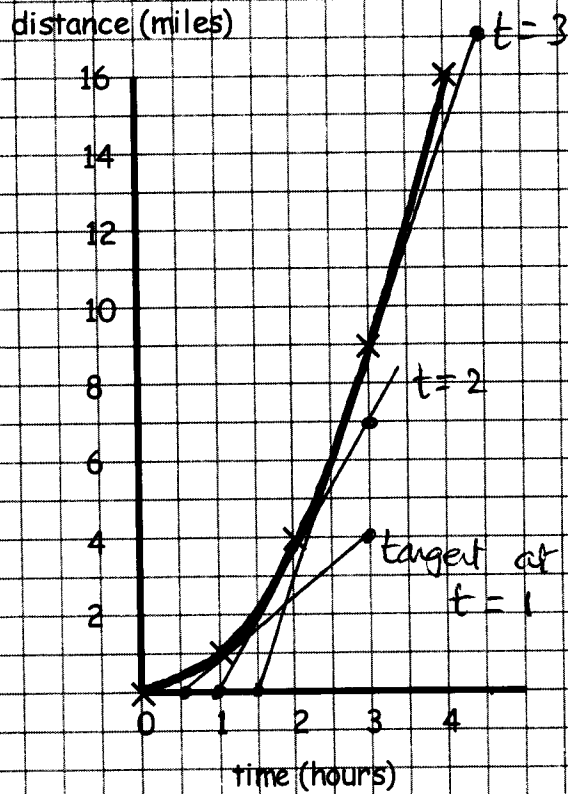
In 1 minute this would be 805 m. $48300 \div 60$

In 1 second this would be 13.4 m. $805 \div 60$

So 30 mph is 13.4 m/s.

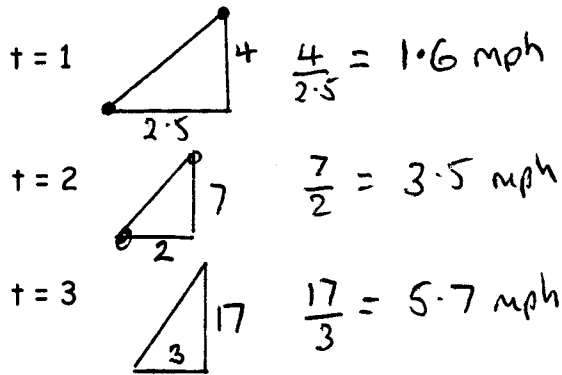
NOTE: As tangents are drawn by hand, answers may differ slightly.

Speed

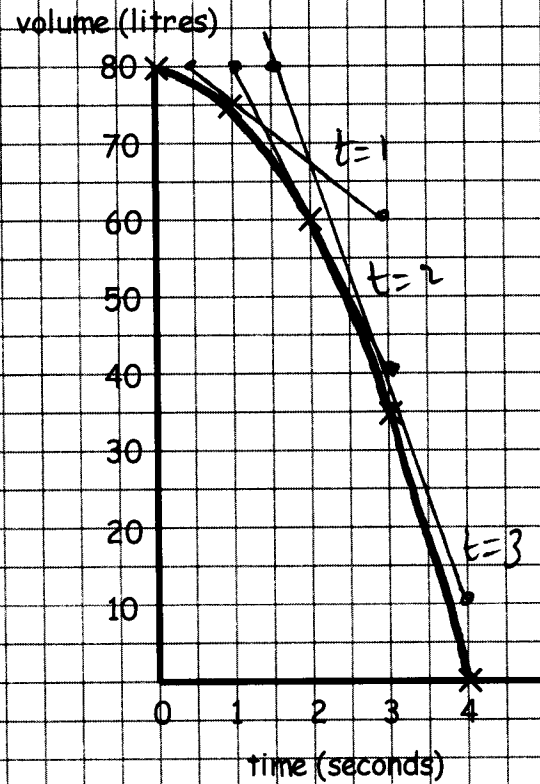


Speed is the gradient of the graph.

By drawing tangents find the speed at these times. (remember to use the scale)

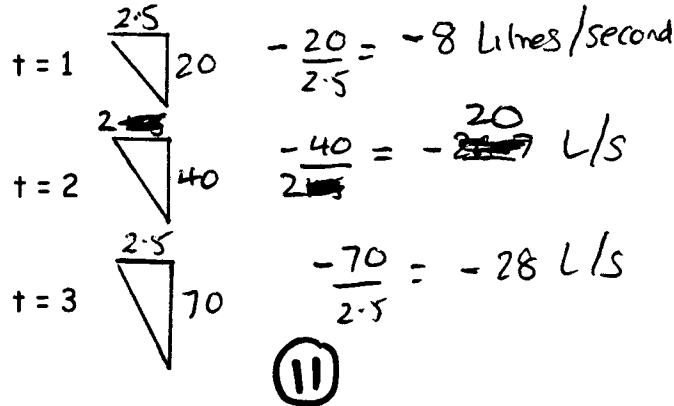


Draining a tank of water

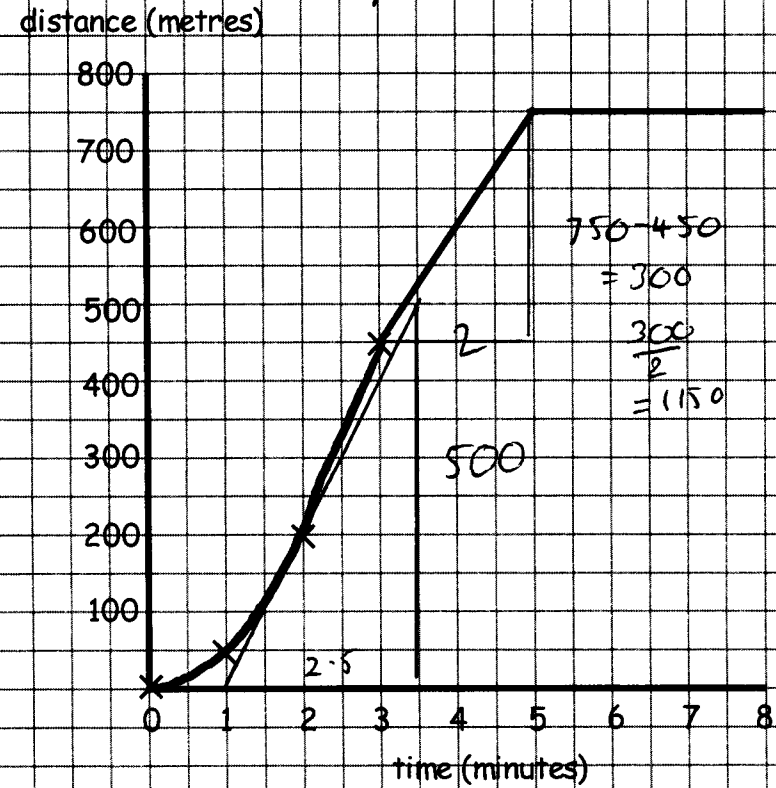


Rate of flow is the gradient of the graph.

By drawing tangents find the speed at these times. (remember to use the scale)



Cyclist



Speed is the gradient of the graph.

The graph is split into three sections in terms of the speed of the cyclist.

Minutes 0 to 2.5 the speed is increasing/decreasing constant/zero

Minutes 2.5 to 3.5 the speed is increasing/decreasing constant/zero

Minutes 3.5 to 8 the speed is increasing/decreasing constant/zero

Find the speed at t = 2 and t = 4
 t = 2 $\frac{500}{2.5} = 200 \text{ m/min}$ t = 4 150 m/min