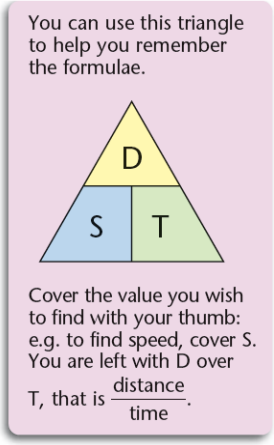
Compound measures: speed

Sometimes you need to work with two units at the same time. For example, the speed of a car can be measured in miles per hour – a measurement involving a unit of length and a unit of time.

For an object moving at a constant speed:

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

Typical units are miles per hour, and metres per second.



Usually the speed of a car is not constant for the whole journey so you use the average speed:

$$average\ speed = \frac{total\ distance\ travelled}{total\ time\ taken}$$

Example 1

What speed does my car average if I travel 90 miles in 3 hours?

$$average\ speed = \frac{total\ distance\ travelled}{total\ time\ taken} = 90 \div 3 = 30\ miles\ per\ hour$$

Example 2

How long does it take to travel 400 miles at a constant speed of 50 miles per hour ?

$$time = \frac{distance}{speed} = 400 \div 50 = 8\ hours$$

Example 3

How far can you go if you travel for 3 hours at 10 miles per hour?

$$distance = speed \times time = 3 \times 10 = 30\ miles$$

Exercises

1 Elizabeth walked for 3 hours at 4 miles per hour. How far did she walk?

2 Andrew drove 100 miles in 4 hours. At what average speed did he travel?

3 Karen drove 300 miles at an average speed of 60 miles per hour. How long did her journey take her?

4 David was travelling by canal boat and went 30 miles in 8 hours. At what average speed was he travelling?

5 Amanda rode her bike for 3 hours and travelled 21 miles. At what average speed was she travelling?

6 Gerry ran for 2 hours and covered 16 miles. At what average speed was he running?

7 Brigit swam for 3 hours and travelled 4 miles. At what average speed was she swimming?

8 Alfred set off from home at 8 am. He travelled 200 miles by car and arrived at 11 am. At what average speed was he travelling?

9 Jason set off for work at 07:55. He arrived at work at 08:10. If he lives 5 miles from work, at what average speed did he travel?

10 Frances was using a keep fit treadmill. She ran for 40 minutes and ‘travelled’ 10 kilometres. At what average speed was she running?

Calculating time

You need to know that:

60 seconds	= 1 minute	60 minutes	= 1 hour	24 hours	= 1 day
365 days	= 1 year	366 days	= 1 leap year		
3 months	= 1 quarter	12 months	= 1 year		

Many people make mistakes when they are calculating with time because they forget that there are 60 minutes in an hour and not 100.

Example 1 Change 2.4 hours into hours and minutes.
Step 1 Keep the 2 hours.
Step 2 Multiply the 0.4 hours by 60 (the number of minutes in an hour).
Step 3 Put the numbers together.
2 hours and 0.4x60 minutes = 2 hours and 24 minutes

Example 2 Change 5 hours 48 minutes into hours.
Step 1 Keep the 5 hours.
Step 2 Divide the 48 minutes by 60 (the number of minutes in an hour).
Step 3 Put the numbers together.
5 hours and 48/60 hours = 5 hours and 0.8 hours = 5.8 hours

Exercises

1 Change these times into hours and minutes.

(a) 2.5 hours

(b) 3.6 hours

(c) 5 ½ hours

d) 3 ¾ hours

(e) 4.1 hours

(f) 3.25 hours

(g) 1.125 hours

(h) 2.7 hours

2 Change these times into decimals of an hour.

(a) 2 hours 30 minutes

(b) 5 hours 15 minutes

(c) 3 hours 36 minutes

(d) 4 hours 12 minutes

(e) 6 hours 20 minutes

(f) 3 hours 18 minutes

(g) 12 hours 45 minutes

(h) 8 hours 3 minutes

3 Sam worked out his time for a journey using the formula $time = \frac{distance}{speed}$

Sam travelled a distance of 90 miles at a speed of 40 miles per hour. He said that the journey took 2 hours and 25 minutes. Explain why Sam was wrong.

Changing units

You need to be able to change units of speed between kilometres per hour, metres per second and miles per hour.

Example 1

Change 10 metres per second to kilometres per hour.

First of all you need to find how many metres are travelled in 1 hour.
So you need to multiply by 60x60=3600.

- In 1 second distance travelled = 10m
- In 1 hour distance travelled = 10x3600 = 36,000m

Divide by 1000 to change m to km.

- In 1 hour distance travelled = 36,000 / 1,000 = 36 km
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So the speed in kilometres per hour is 36 km per hour (or 36 $km.h^{-1}$).

Example 2

Change 60 miles per hour to **(a)** kilometres per hour **(b)** metres per second.
(Use 5 miles = 8 km)

(a) In 1 hour distance travelled = 60 miles = 60x8/5 = 96 km
So the speed is 96 km per hour (or 96 $km.h^{-1}$).

(b) In 1 hour distance travelled = 96 km = 96,000 m
In 1 second distance travelled = 96,000 / 3,600 = 26,66 m
So the speed is 26.7 m/s (or 26.7$m.s^{-1}$) (to 3 s.f.).

Exercises

1 Change 20 metres per second to metres per hour.

2 Change 30 km per hour to metres per second.

3 Change 60 miles per hour to miles per minute.

4 Change 15 metres per second to km per hour.

5 Change 20 metres per second to kilometres per hour.

6 Change 80 km per hour to metres per minute.

7 Sybil travels 80 kilometres in 4 hours. What is her average speed in metres per second ?

8 An electron travels at 600 000 metres per second. What is this speed in km per hour ?

9 A rocket must travel at 11 000 metres per second to escape the gravitational pull of the Earth. What is this speed in kilometres per hour?

10 The fastest land animal is the cheetah, which can travel at 70 miles per hour. Approximately what is this speed in metres per second?