R11a Part 1 Speed, distance, and time

Warm-up activity

Work out the following

a) $15 \div 5 = 3$

b) $28 \div 4 = 7$

c) $56 \div 7 = 8$

d) $310 \div 10 = 31$

e) $112 \div 8 = 14$

$$8\overline{)11^{3}2}\quad 14$$

f) $108 \div 9 = 12$

$$9\overline{)10'8}\quad 12$$

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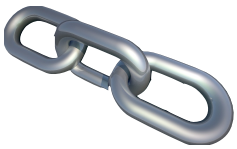
Spot the links…



Work out the average speed of the car in km/h in each case.
Try to spot what is changing from each question to the next to help you.

a) A car travels 80 km in 2 hours

$$\frac{80\text{ km}}{2\text{h}} = 40\text{ km/h}$$

b) A car travels 40 km in 2 hours

$$\frac{40\text{ km}}{2\text{h}} = 20\text{ km/h}$$

c) A car travels 40 km in 1 hour

$$\frac{40\text{ km}}{1\text{ h}} = 40\text{ km/h}$$

d) A car travels 40 km in 30 minutes

$$\frac{40\text{ km}}{0.5\text{ h}} = 80\text{ km/h}$$

e) A car travels 20 km in 30 minutes

$$\frac{20\text{ km}}{0.5\text{ h}} = 40\text{ km/h}$$

f) A car travels 20 km in 20 minutes

$$\frac{20\text{ km}}{\frac{1}{3}\text{ h}} = 60\text{ km/h}$$

g) A car travels 20 km in 40 minutes

$$\frac{20\text{ km}}{\frac{2}{3}\text{ h}} = 30\text{ km/h}$$

h) A car travels 60 km in 40 minutes

$$\frac{60\text{ km}}{\frac{2}{3}\text{ h}} = 90\text{ km/h}$$

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a

Alpha Exercise

$$\text{Average speed} = \frac{\text{Distance travelled}}{\text{Time taken}}$$

a) Pascal is training for a marathon. He runs **42 km** in **3 hours**. Work out his average speed in km/h.

$$\text{Average speed} = \frac{42 \text{ km}}{3 \text{ h}} = 14 \text{ km/h}$$

b) A plane travels **4200 miles** in **7 hours**. Work out its average speed in mph.

$$\text{Average speed} = \frac{4200 \text{ miles}}{7 \text{ h}} = 600 \text{ miles/h}$$

c) Jon runs **10 km** in **30 minutes**. Find his average speed in km/h.

$$\text{Average speed} = \frac{10 \text{ km}}{0.5 \text{ h}} = 20 \text{ km/h}$$

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β

Beta Exercise

$$\text{Average speed} = \frac{\text{Distance travelled}}{\text{Time taken}}$$

a) Chris walks **2.8 km** in **30 minutes**. Work out his average speed in km/h.

$$\text{Average speed} = \frac{2.8 \text{ km}}{0.5 \text{ h}} = 5.6 \text{ km/h}$$

b) Laura cycles a lap of the park at **12 metres per second**. The lap takes **58 seconds**. What distance does she cover?

$$\text{Distance travelled} = \text{Average speed} \times \text{time taken}$$

$$= 12 \text{ m/s} \times 58 \text{s} = 696 \text{ m}$$

c) Roberto is a racing driver. He completes a **500 mile** race at an average speed of **125 miles per hour**. How long did it take him to complete the race?

$$\text{Time taken} = \frac{\text{Distance travelled}}{\text{Average speed}}$$

$$= \frac{500 \text{ miles}}{125 \text{ miles/h}} = 4 \text{ hours}$$

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Gamma Exercise

a) Jules runs **9 km** in **40 min**. What is her average speed in km/h?

40 min = $\frac{2}{3}$ h

$\frac{9\text{ km}}{\left(\frac{2}{3}\right)\text{h}} = 9 \times \frac{3}{2}$ km/h = 13.5 km/h

b) A sprinter runs **100 metres** in **10 seconds**. Work out his average speed in m/s. What is this speed in km/h?

$\frac{100\text{ m}}{10\text{ s}}$ = 10 m/s = 36,000 m/h = 36 km/h

3600 s in 1 hr

1000 m in 1 km.

c) The average speed on a moderately busy motorway is **48 mph**. How many minutes will it take to complete **4 miles** at this speed?

Time taken = $\frac{4\text{ miles}}{48\text{ mph}}$ = $\frac{1}{12}$ h = $\frac{1}{12}$ of 60 min = 5 min

d) At what speed would you need to travel to complete a **3 mile journey** in **18 minutes**?

3 miles in 18 min ⇒ 1 mile every 6 min

⇒ 10 miles every 60 min

i.e. 10 miles per hour

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Explain the mistake

Kat answers this question as follows:

A train covers 27 km in 18 minutes. Find the average speed of the train.

$$\text{Speed} = \frac{\text{Distance}}{\text{time}} = \frac{27}{18} = 1.5 \text{ km/h}$$

Kat has made a mistake. What is it?

$\frac{27 \text{ km}}{18 \text{ min}}$ gives a speed of 1.5 km/min. Since there are 60 minutes in an hour, this is actually

$60 \times 1.5 = 90$ km/h

Exam-style question 1

A tortoise and a hare have an 800 metre race.
The hare completes the first **half** of the race in 50 seconds.

(a) What is the hare's average speed for this part of the race? Give your answer in m/s.

$$\text{Average speed} = \frac{\text{Distance travelled}}{\text{Time taken}} = \frac{800 \text{ m}}{50 \text{ s}} = 16 \text{ m/s}$$

The tortoise completes the first **half** of the race in 15 minutes.

(b) What is the tortoise's average speed for this part of the race? Give your answer in km/h.

400m in 15 min is 0.4 km in 0.25 hours

$$\text{Average speed} = \frac{\text{Distance travelled}}{\text{Time taken}} = \frac{0.4 \text{ km}}{0.25 \text{ hr}} = \frac{40}{25} \text{ km/h}$$

1.6 km/h

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Exam-style question 2

A cyclist travels a distance of 7.2 km, correct to the nearest 0.1 km.

The cyclist took 12 minutes to cover this distance, to the nearest minute.

a) Work out the upper bound for the speed of the cyclist in m/s, correct to 3 significant figures.

UB for speed = $\frac{\text{UB for distance}}{\text{LB for time}}$

$= \frac{7.25\text{ km}}{11.5\text{ min}} = \frac{7250\text{ m}}{690\text{ s}}$

$= 10.507\ldots = 10.5\text{ m/s}$ to 3 s.f.

b) What is the upper bound for the speed of the cyclist in km/h, correct to 3 significant figures?

$\frac{7.25\text{ km}}{11.5\text{ min}} = 0.6304\ldots\text{ km/min}$

$= 60 \times 0.6304\ldots\text{ km/h}$

$= 37.826\ldots\text{ km/h}$

$= 37.8\text{ km/h}$ to 3 s.f.

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Challenge

Carlos and Luis are travelling by car from Barcelona to Madrid.

Carlos drives the first half of the distance at an average speed of 60 km/h.
Luis drives the second half of the distance at an average speed of 40 km/h.

Assuming that the time spent swapping drivers at the halfway point took a negligible amount of time, what was the average speed over the whole journey?

Let x km = half the distance from Barcelona to Madrid

$$\text{Average speed} = \frac{\text{Distance travelled}}{\text{Time taken}} \Rightarrow \text{Time taken} = \frac{\text{Distance travelled}}{\text{Average speed}}$$

So time taken for first half $= \frac{x}{60}$

And time taken for second half $= \frac{x}{40}$

$$\text{Total journey time} = \frac{x}{60} + \frac{x}{40} = \frac{2x}{120} + \frac{3x}{120}$$

$$= \frac{5x}{120} \text{ hours}$$

Total distance from Barcelona to Madrid $= x + x = 2x$ km

$$\text{Average speed} = \frac{2x}{\left(\frac{5x}{120}\right)} = 2x \times \frac{120}{5x} = \frac{240x}{5x}$$

$$= 48 \text{ km/h}$$