

## Unit conversion: Speed

### Practice examples

Remember that units for speed all look like  $\frac{(\text{distance})}{(\text{time})}$ . If you're converting from one speed unit to another, say 20 km/h to m/s, write down the value you start with:

$$20 \frac{\text{km}}{\text{h}}$$

Now look at the units you want to end up with.

- a) You want to convert km to m, and you know

$$1 \text{ km} = 1000 \text{ m, or } 1 = \frac{1 \text{ km}}{1000 \text{ m}} = \frac{1000 \text{ m}}{1 \text{ km}}$$

You started with km on the top, so you eliminate that by multiplying by the equation with km on the *bottom*. Hence you multiply your number by  $\frac{1000 \text{ m}}{1 \text{ km}}$ .

- b) You want to convert h to s, and you know

$$1 \text{ h} = 3600 \text{ s, or } 1 = \frac{1 \text{ h}}{3600 \text{ s}} = \frac{3600 \text{ s}}{1 \text{ h}}$$

You started with h on the bottom, so you eliminate that by multiplying by the equation with h on the *top*. Hence you multiply your number by  $\frac{1 \text{ h}}{3600 \text{ s}}$ .

So your final answer is:

$$20 \text{ km/h} = 20 \frac{\text{km}}{\text{h}} \times \frac{1000 \text{ m}}{1 \text{ km}} \times \frac{1 \text{ h}}{3600 \text{ s}} = \frac{20 \times 1000}{3600} = 5.6 \text{ m/s}$$

*Have a go:* Convert each quantity to the units given:

- 80 km/h = \_\_\_\_\_ m/s
- 500 km/day = \_\_\_\_\_ m/s
- 65 miles/h = \_\_\_\_\_ km/h (1 mile = 1.609 km)
- 20 m/s = \_\_\_\_\_ km/h
- 90 cm/s = \_\_\_\_\_ km/h
- 5000 km/year = \_\_\_\_\_ cm/s
- 20 cm/s = \_\_\_\_\_ km/day
- (Harder) Using a pedometer, you walk 3000 steps in 20 minutes, so your speed is 150 steps/min. Each of your steps is 0.7 m long. What is your speed?  
  
150 steps/min = \_\_\_\_\_ m/s = \_\_\_\_\_ km/h
- (From pre-lecture quiz): A snail travels 0.02 km in a week. What is its average speed in metres per second?

## Answers

1.  $80 \text{ km/h} = 80 \frac{\text{km}}{\text{h}} \times \frac{1000 \text{ m}}{1 \text{ km}} \times \frac{1 \text{ h}}{3600 \text{ s}} = \frac{80 \times 1000}{3600} = 22.2 \text{ m/s}$
2.  $500 \text{ km/day} = 500 \frac{\text{km}}{\text{day}} \times \frac{1000 \text{ m}}{1 \text{ km}} \times \frac{1 \text{ day}}{24 \text{ h}} \times \frac{1 \text{ h}}{3600 \text{ s}} = \frac{500 \times 1000}{24 \times 3600} = 5.8 \text{ m/s}$
3.  $65 \text{ miles/h} = 65 \frac{\text{miles}}{\text{h}} \times \frac{1.609 \text{ km}}{1 \text{ mile}} = \frac{65 \times 1.609}{1} = 105 \text{ km/h}$

4.  $20 \text{ m/s} = 20 \frac{\text{m}}{\text{s}} \times \frac{1 \text{ km}}{1000 \text{ m}} \times \frac{3600 \text{ s}}{1 \text{ h}} = \frac{20 \times 3600}{1000} = 72 \text{ km/h}$

5.  $90 \text{ cm/s} = 90 \frac{\text{cm}}{\text{s}} \times \frac{1 \text{ m}}{100 \text{ cm}} \times \frac{1 \text{ km}}{1000 \text{ m}} \times \frac{3600 \text{ s}}{1 \text{ h}} = \frac{90 \times 3600}{100 \times 1000} = 3.2 \text{ km/h}$

*Note: If you remember that 100,000 cm = 1 km, you can skip a step and write*

$$90 \text{ cm/s} = 90 \frac{\text{cm}}{\text{s}} \times \frac{1 \text{ km}}{100,000 \text{ cm}} \times \frac{3600 \text{ s}}{1 \text{ h}} = \frac{90 \times 3600}{100,000} = 3.2 \text{ km/h}$$

6.  $5000 \text{ km/year} =$   
 $5000 \frac{\text{km}}{\text{year}} \times \frac{100,000 \text{ cm}}{1 \text{ km}} \times \frac{1 \text{ year}}{365 \times 24 \times 3600 \text{ s}} = \frac{5000 \times 100,000}{365 \times 24 \times 3600} = 15.8 \text{ cm/s}$

7.  $20 \text{ cm/s} = 20 \frac{\text{cm}}{\text{s}} \times \frac{1 \text{ km}}{100,000 \text{ cm}} \times \frac{24 \times 3600 \text{ s}}{1 \text{ day}} = \frac{20 \times 24 \times 3600}{100,000} = 17.3 \text{ km/day}$

8. Using a pedometer, you walk 3000 steps in 20 minutes, so your speed is 150 steps/min. Each of your steps is 0.7 m long. What is your speed?

$$150 \text{ steps/min} = 150 \frac{\text{steps}}{\text{min}} \times \frac{0.7 \text{ m}}{1 \text{ step}} \times \frac{1 \text{ min}}{60 \text{ s}} = \frac{150 \times 0.7}{60} = 1.75 \text{ m/s}$$

or

$$150 \text{ steps/min} = 150 \frac{\text{steps}}{\text{min}} \times \frac{0.7 \text{ m}}{1 \text{ step}} \times \frac{1 \text{ km}}{1000 \text{ m}} \times \frac{60 \text{ min}}{1 \text{ h}} = \frac{150 \times 0.7 \times 60}{1000} = 6.3 \text{ km/h}$$

9. A snail travels 0.02 km in a week. What is its average speed in metres per second?

$$\begin{aligned}0.02 \frac{\text{km}}{\text{week}} &= 0.02 \frac{\text{km}}{\text{week}} \times \frac{1000 \text{ m}}{1 \text{ km}} \times \frac{1 \text{ week}}{7 \text{ days}} \times \frac{1 \text{ day}}{24 \times 60 \times 60 \text{ s}} \\ &= 3.3 \times 10^{-5} \text{ m/s}\end{aligned}$$

which we round to  $3 \times 10^{-5} \text{ m/s}$  (since we were only given 1 significant figure in the question) = answer 1.