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:

\[
\frac{20 \text{ km}}{\text{h}}
\]

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

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

\[
1 \text{ km} = 1000 \text{ m}, \quad \frac{1 \text{ km}}{1000 \text{ m}} = \frac{1000 \text{ m}}{1 \text{ km}}
\]

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

\[
1 \text{ h} = 3600 \text{ s}, \quad \frac{1 \text{ h}}{3600 \text{ s}} = \frac{3600 \text{ s}}{1 \text{ h}}
\]

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:

1. 80 km/h = _________________ m/s
2. 500 km/day = _________________ m/s
3. 65 miles/h = _________________ km/h  
   \( 1 \text{ mile} = 1.609 \text{ km} \)
4. 20 m/s = _________________ km/h
5. 90 cm/s = _________________ km/h
6. 5000 km/year = _________________ cm/s
7. 20 cm/s = _________________ km/day
8. (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?

\[
150 \text{ steps/min} = \frac{150 \text{ steps}}{1 \text{ min}} \times \frac{0.7 \text{ m}}{1 \text{ step}} = 105 \text{ m/min} = \frac{105 \text{ m}}{1 \text{ min}} \times \frac{1 \text{ km}}{1000 \text{ m}} = 0.105 \text{ km/min} = 6.3 \text{ km/h}
\]

9. (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. \[ 5000 \text{ km/year} = \frac{5000 \text{ km}}{\text{year}} \times \frac{100,000 \text{ cm}}{1 \text{ km}} \times \frac{1 \text{ year}}{365 \times 24 \times 3600 \text{ s}} = \frac{5000 \times 100,000}{365 \times 24 \times 3600} = 15.8 \text{ cm/s} \]

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?

\[
0.02 \text{ km/week} = 0.02 \text{ km/week} \times \frac{1000 \text{ m}}{1 \text{ km}} \times \frac{1 \text{ week}}{7 \text{ days}} \times \frac{1 \text{ day}}{24 \times 60 \times 60 \text{ s}}
\]

\[= 3.3 \times 10^{-5} \text{ m/s} \]

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