

multiply by one, written as a fraction, until the units you do not want cancel

A unit is part of the answer *

- every conversion factor is a fraction worth exactly 1, because its top and bottom are the same amount written two ways: 60 minutes over 1 hour
- multiplying by 1 changes the number and never the quantity, which is why a conversion chain can be as long as it needs to be
- write each factor so the unit you want to LOSE sits diagonally opposite itself, once on top and once underneath. It then cancels
- a rate carries two units, one over the other. Reading kilometres per hour as a single fraction is what makes it convertible at all

The shapes that keep coming back

speed, distance and time $v = \frac{d}{t}$

density of a material $\rho = \frac{m}{V}$

population density, people per unit area $D = \frac{N}{A}$

a conversion factor, worth 1 $1 = \frac{60 \text{ minutes}}{1 \text{ hour}}$



the time ladder in order. One factor per step, and each step is a multiplication by 60 going right or a division by 60 coming back

all four are the same object: a quantity divided by another quantity. Once it is written as a fraction, converting it is just multiplying by more fractions

Worked: a rate across a unit boundary

Q. a tap runs at 18 litres per minute. How many litres does it deliver in 2.5 hours?

- the rate is per MINUTE and the time is in HOURS, so one of them has to move
- convert the time: $2.5 \times 60 = 150$ minutes
- now the units match: $150 \times 18 = 2700$
- check the unit of the answer: minutes times litres per minute leaves litres, which is what was asked for

Answer **2700 litres**

Four rates, one idea

Speed

distance per unit time, so kilometres per hour or metres per second

Density

mass per unit volume, so grams per cubic centimetre

Population density

people per unit area, so people per square kilometre

Unit price

cost per unit amount, so rupees per litre or per kilogram

each is a quantity divided by another quantity, and each converts the same way: fix the top, fix the bottom, then divide