

COMPOUND MEASURES

Task 1

- 1) A cyclist travels 45 km in 1 hour 30 minutes.
What is their average speed in km/h?
 $45 \div 1.5 = 30 \text{ km/h}$
- 2) A train travels 120 miles in 2 hours 30 minutes. What is its average speed in mph?
 $120 \div 2.5 = 48 \text{ mph}$
- 3) A swimmer covers 400 m in 5 minutes.
What is their average speed in m/s?
 $400 \div 300 = 1.33 \text{ m/s (3 sf)}$
- 4) A lorry driver travels 275 km in 5 hours.
What is their average speed in km/h?
 $275 \div 5 = 55 \text{ km/h}$
- 5) A sprinter completes 200 m in 20 seconds.
What is their speed in m/s?
 $200 \div 20 = 10 \text{ m/s}$
- 6) A car travels at 65 mph for 2 hours 15 minutes. How far does the car travel?
 $2 \text{ hours } 15 \text{ minutes} = 2.25 \text{ hours}$
 $65 \times 2.25 = 146.25 \text{ miles}$
- 7) A ship sails at 25 km/h for 3.6 hours. How far does the ship travel?
 $25 \times 3.6 = 90 \text{ km}$
- 8) A bus travels 156 miles at a speed of 52 mph. How long does the journey take?
 $156 \div 52 = 3 \text{ hours}$
- 9) A cheetah runs 420 m at a speed of 21 m/s.
How long does it take?
 $420 \div 21 = 20 \text{ seconds}$
- 10) Convert 90 km/h into m/s.
 $90 \times 1000 \div (60 \times 60) = 25 \text{ m/s}$

Task 2

- 11) A block has a mass of 250 g and a volume of 50 cm^3 . Calculate its density.
 $250 \div 50 = 5 \text{ g/cm}^3$
- 12) A stone has a density of 3 g/cm^3 and a volume of 400 cm^3 . Work out its mass in kg.
 $3 \times 400 = 1200 \text{ g} = 1.2 \text{ kg}$
- 13) A liquid has a mass of 5.4 kg and a volume of 3 litres. Find its density in g/ml.
 $5.4 \text{ kg} = 5400 \text{ g}$
 $3 \text{ litres} = 3000 \text{ ml}$
 $5400 \div 3000 = 1.8 \text{ g/ml}$
- 14) A box has a density of 0.8 g/cm^3 and a mass of 640 g. Work out the volume of the box.
 $640 \div 0.8 = 800 \text{ cm}^3$
- 15) A machine exerts a force of 1200 N on the ground with an area of 0.25 m^2 . Calculate the pressure.
 $1200 \div 0.25 = 4800 \text{ N/m}^2$
- 16) The pressure on the ground from a suitcase is 4000 N/m^2 . The suitcase's weight has a force of 320 N. Work out the area of contact the suitcase has with the ground.
 $320 \div 4000 = 0.08 \text{ m}^2$
- 17) A person exerts a force of 600 N on a floor, while standing on two feet. Given, each foot has an area of 0.03 m^2 , calculate the pressure on the floor.
 $\text{Total area} = 0.06 \text{ m}^2$
 $600 \div 0.06 = 10,000 \text{ N/m}^2$

18) A force of 600 N acts over an area of 300 cm². Work out the pressure in N/m².

$$300 \text{ cm}^2 \div 100^2 = 0.03 \text{ m}^2$$

$$600 \div 0.03 = 20,000 \text{ N/m}^2$$

19) A block of metal has a mass of 2.4 kg and a density of 8 g/cm³. Work out the volume in cm³.

$$2.4 \text{ kg} = 2400 \text{ g}$$

$$2400 \div 8 = 300 \text{ cm}^3$$

20) A tank holds 2500 ml of liquid with a density of 1.2 g/ml. Find the mass of the liquid in kilograms.

$$2500 \times 1.2 = 3000 \text{ g} = 3 \text{ kg}$$

Task 3

21) A train travels 225 km in 3 hours and 45 minutes. Work out the speed of the train in m/s.

$$225 \div 3.75 = 60 \text{ km/h}$$

$$60 \times 1000 \div (60 \times 60) = 16.7 \text{ m/s (3 sf)}$$

22) A cube with a side length of 5 cm has a mass of 2.7 kg. Work out its density in g/cm³.

$$\text{Volume} = 5^3 = 125 \text{ cm}^3$$

$$\text{Mass} = 2700 \text{ g}$$

$$\text{Density} = 2700 \div 125 = 21.6 \text{ g/cm}^3 \text{ (3 sf)}$$

23) A rectangular block measures 20 cm × 15 cm × 10 cm. Its mass is 12 kg. Find its density in g/cm³.

$$\text{Volume} = 20 \times 15 \times 10 = 3000 \text{ cm}^3$$

$$\text{Mass} = 12,000 \text{ g}$$

$$\text{Density} = 12,000 \div 3000 = 4 \text{ g/cm}^3$$

24) A car tyre has a surface area of 0.04 m² in contact with the road. If the car has a total weight of 12,000 N spread equally across 4 tyres, calculate the pressure each tyre exerts on the road.

$$\text{Weight per tyre} = 3000 \text{ N}$$

$$\text{Pressure} = 3000 \div 0.04 = 75,000 \text{ N/m}^2$$

25) A diver weighs 800 N. He wears flippers with a total area of 0.12 m². Calculate the pressure he exerts on the seabed to the nearest unit. Compare this with the pressure if he stood barefoot with an area of 0.025 m².

$$\text{With flippers: } 800 \div 0.12 = 6667 \text{ N/m}^2 \text{ (unit)}$$

$$\text{Barefoot: } 800 \div 0.025 = 32,000 \text{ N/m}^2$$

Much less pressure with flippers.

26) Sophie cycles 72 km from Oxford to Cambridge. She cycles the first 45 km at an average speed of 18 km/h. The remainder of the journey takes her 1 hour and 10 minutes. Work out Sophie's average speed for the whole journey. Give your answer to 3 significant figures.

$$\text{First 45 km at 18 km/h}$$

$$\text{Time} = 45 \div 18 = 2.5 \text{ h}$$

$$\text{Remaining distance} = 72 - 45 = 27 \text{ km}$$

$$\text{Given time for remainder} = 1 \text{ h } 10 \text{ min}$$

$$\text{Total time} = 2\frac{1}{2} + 1\frac{1}{6} = \frac{11}{3} \text{ h}$$

$$\begin{aligned} \text{Average speed} &= 72 \div \left(\frac{11}{3}\right) \\ &= \frac{216}{11} \\ &= 19.6363... \end{aligned}$$

$$19.6 \text{ km/h (3 sf)}$$

27) Daniel swims 1,500 m in 22 minutes and 18 seconds.

a. Work out how long it would take Daniel to swim 3,000 m at the same speed. Give your answer in minutes and seconds.

Convert time to seconds:

$$(22 \times 60) + 18 = 1338 \text{ s}$$

At same speed, 3000 m takes double the time:

$$(2 \times 1338) = 2676 \text{ s}$$

$$2676 \div 60 = 44.6 \text{ minutes}$$

$$44 \text{ min } 36 \text{ s}$$

- b. Daniel tires quickly after 2,000 m.
How would this affect your answer to part a?

If speed decreases, time increases. It would take more time.

Average speed

= total distance ÷ total time

$$= d \div \left(\frac{3d}{4x} \right) = \frac{4x}{3}$$

Challenge

- 28) 250 ml of cranberry juice and 350 ml of apple juice are mixed to make a fruit drink. The cranberry juice has a density of 0.9 g/ml. The apple juice has a density of 1.15 g/ml. Work out the density of the fruit drink. Give your answer to 3 decimal places.

Mass of cranberry juice
= $0.9 \times 250 = 225$ g

Mass of apple juice
= $1.15 \times 350 = 402.5$ g

Total mass = $225 + 402.5 = 627.5$ g

Total volume = $250 + 350 = 600$ ml

Density of the fruit drink
= $627.5 \div 600$
= $1.04583\dots$ g/ml
= **1.046 g/ml (3 dp)**

- 29) Emma drives a total of d miles. She drives the first half of the journey at x mph. She drives the second half of the journey at $2x$ mph. Write a fully simplified expression, in terms of d and x , for Emma's average speed for the whole journey.

First half of journey:

$$\text{time} = \left(\frac{d}{2} \right) \div x = \frac{d}{2x}$$

Second half of journey:

$$\text{time} = \left(\frac{d}{2} \right) \div 2x = \frac{d}{4x}$$

$$\text{Total time} = \frac{d}{2x} + \frac{d}{4x}$$

$$= \frac{2x}{4x} + \frac{d}{4x}$$

$$= \frac{3d}{4x}$$

- 30) A mixture is made by combining:

a ml of a liquid with density p g/ml, and

b ml of a liquid with density q g/ml.

Write a fully simplified expression for the density of the mixture in terms of a , b , p , and q .

Mass from first liquid = $a \times p$

Mass from second liquid = $b \times q$

Total mass = $ap + bq$

Total volume = $a + b$

Density of mixture

= (total mass) ÷ (total volume)

$$= \frac{ap+bq}{a+b}$$