



# 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<sup>3</sup>. Calculate its density.

$$250 \div 50 = 5 \text{ g/cm}^3$$

12) A stone has a density of 3 g/cm<sup>3</sup> and a volume of 400 cm<sup>3</sup>. 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<sup>3</sup> 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<sup>2</sup>. 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<sup>2</sup>. 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<sup>2</sup>, 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 cm<sup>2</sup>. Work out the pressure in N/m<sup>2</sup>.

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

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

19) A block of metal has a mass of 2.4 kg and a density of 8 g/cm<sup>3</sup>. Work out the volume in cm<sup>3</sup>.

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

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

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/cm<sup>3</sup>.

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

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

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

23) A rectangular block measures 20 cm × 15 cm × 10 cm. Its mass is 12 kg. Find its density in g/cm<sup>3</sup>.

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

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

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

24) A car tyre has a surface area of 0.04 m<sup>2</sup> 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 m<sup>2</sup>. 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 m<sup>2</sup>.

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

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

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.

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

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

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

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

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

$$\text{Average speed} = 72 \div \left( \frac{11}{3} \right)$$

$$= \frac{216}{11}$$

$$= 19.6363\dots$$

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

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.

### 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  
 $= 0.9 \times 250 = 225 \text{ g}$

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

Total mass =  $225 + 402.5 = 627.5 \text{ g}$

Total volume =  $250 + 350 = 600 \text{ ml}$

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

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

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

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

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

Average speed

$$\begin{aligned} &= \text{total distance} \div \text{total time} \\ &= d \div \left(\frac{3d}{4x}\right) = \frac{4x}{3} \end{aligned}$$

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

$$\begin{aligned} &= (\text{total mass}) \div (\text{total volume}) \\ &= \frac{ap+bq}{a+b} \end{aligned}$$