Worksheet - Speed, density and compound units

Year: Year 8 · 20

Show your working.

Question 1

Question 1 – Speed, distance and time *(Section A · Skills practice)*

Use $\text{speed} = \dfrac{\text{distance}}{\text{time}}$ and its rearrangements. Include units in each answer.

a. A train travels 150 km in 2.5 hours. Find its speed.
b. A cyclist rides at 18 km/h for 3 hours. How far does she go?
c. A bus travels 90 miles at 45 mph. How long does it take?
d. A runner covers 400 m in 50 seconds. Find her speed in m/s.

Question 2

Question 2 – Time in hours and minutes *(Section A · Skills practice)*

Time is not a decimal number. Convert carefully.

a. Write 2 h 45 min as a decimal number of hours.
b. Write 3.4 hours in hours and minutes.
c. A car travels 85 miles in 1 h 40 min. Find its average speed in mph.
d. How long does it take to cycle 27 km at 18 km/h? Give your answer in hours and minutes.

Question 3

Question 3 – Changing the units of speed *(Section A · Skills practice)*

Convert each speed. For km/h to m/s divide by 3.6, and for m/s to km/h multiply by 3.6.

a. 72 km/h in m/s
b. 15 m/s in km/h
c. 90 km/h in m/s
d. 8 m/s in km/h

Question 4

Question 4 – Average speed *(Section A · Skills practice)*

Average speed is the total distance divided by the total time.

a. A driver goes 60 km in 1 hour and then 90 km in 1.5 hours. Find the average speed.
b. A cyclist rides 12 km in 30 minutes and then 20 km in 1 hour. Find the average speed in km/h.
c. A runner jogs for 2 hours at 9 km/h and then for 1 hour at 6 km/h. Find the average speed.
d. Explain why the average of 9 and 6 is not the correct answer in part (c).

Question 5

Question 5 – Density *(Section A · Skills practice)*

Density $= \dfrac{\text{mass}}{\text{volume}}$. Find the missing quantity.

a. A block has mass 540 g and volume 200 cm³. Find the density in g/cm³.
b. A metal has density 8 g/cm³. Find the mass of 35 cm³.
c. A liquid has mass 750 g and density 1.5 g/cm³. Find its volume.
d. A cube has side 5 cm and mass 1 000 g. Find its density.

Question 6

Question 6 – Other compound units *(Section A · Skills practice)*

Rates are compound units too. Work out each.

a. A tap fills 120 litres in 8 minutes. Find the flow rate in litres per minute.
b. A town has 36 000 people in 40 km². Find the population density.
c. A car uses 5 litres of petrol for 60 miles. How many miles per litre?
d. Petrol costs £1.40 per litre. What is the cost per mile in pence?

Question 7

Question 7 – The train timetable *(Section B · Real-life practice)*

A train leaves Manchester at 09:10 and arrives in London at 11:25. The distance is 200 miles.

a. How long is the journey in hours and minutes?
b. Write this time as a decimal number of hours.
c. Find the average speed in mph, to 1 decimal place.
d. A faster train takes 1 hour 55 minutes. Find its average speed and how much faster it is.

Question 8

Question 8 – Parkrun *(Section B · Real-life practice)*

Ella runs a 5 km parkrun in 27 minutes 30 seconds. Her friend Raj runs 5 km in 24

minutes.

Runner	Distance	Time
Ella	5 km	27 min 30 s
Raj	5 km	24 min

a. Write Ella's time in minutes as a decimal and in hours.
b. Find the speed of each runner in km/h, to 1 decimal place.
c. How many metres behind Ella is when Raj finishes, assuming both run at constant speeds?
d. Ella wants to run 5 km in 25 minutes. What speed in km/h does she need?

Question 9

Question 9 – Cycling to school *(Section B · Real-life practice)*

Maya cycles 4.8 km to school at an average speed of 16 km/h. On the way home she is tired and her average speed is only 12 km/h.

a. How long does she take to school? Give your answer in minutes.
b. How long does the journey home take?
c. Find her average speed for the whole round trip.
d. Maya says "My average speed is 14 km/h because (16 + 12) ÷ 2 = 14." Is she correct?

Question 10

Question 10 – Flying to Spain *(Section B · Real-life practice)*

A plane flies from London to Madrid, a distance of 1 260 km, at an average speed of 630 km/h. It leaves at 06:50.

a. How long does the flight take?
b. At what time does it land (in UK time)?
c. On the way back there is a headwind and the average speed is 540 km/h. How long does the return flight take?
d. Find the average speed for the whole round trip.

Question 11

Question 11 – Density of metals *(Section B · Real-life practice)*

Scientists measure the density of metals.

Metal	Mass	Volume
Aluminium	405 g	150 cm^3
Iron	630 g	80 cm^3

Metal	Mass	Volume
Gold	965 g	50 cm³

a. Work out the density of each metal in g/cm³.
b. Which metal would float in mercury (density 13.6 g/cm³) and which would sink?
c. Find the mass of a gold bar of volume 1 000 cm³ in kg.
d. A pupil says gold is about 7 times as dense as aluminium. Is this correct?

Question 12

Question 12 – Filling the swimming pool *(Section B · Real-life practice)*

A swimming pool measures 25 m by 10 m, and the water is 1.8 m deep. A pipe fills it at a rate of 5 000 litres per minute. (1 m³ = 1 000 litres.)

a. Find the volume of water in the pool in m³ and in litres.
b. How long does it take to fill the pool? Give your answer in hours and minutes.
c. Water costs £1.80 per m³. How much does it cost to fill the pool?
d. The pool loses 4 litres per second through evaporation and leaks. How much does it lose in a day, in m³?

Question 13

Question 13 – Fuel economy *(Section B · Real-life practice)*

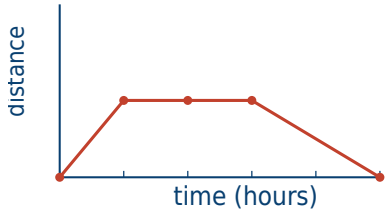
Two cars are compared on a journey of 240 miles. Car A uses 5 gallons of petrol. Car B uses 6.4 gallons.

a. Find the miles per gallon (mpg) of each car.
b. Petrol costs £6.30 per gallon. Find the cost of the journey for each car.
c. Which car is cheaper to run and by how much?
d. Car B has a tank of 12 gallons. How far can it travel on a full tank?

Question 14

Question 14 – A distance-time graph *(Section B · Real-life practice)*

The graph shows Sam's walk. He walks for 1 hour, rests, and then walks home. Distance from home in km against time in hours.



Time (h)	0	1	2	3	5
Distance (km)	0	4	4	4	0

a. How fast does Sam walk in the first hour?
b. How long does he rest?
c. Find his speed on the way home.
d. Find his average speed for the whole walk.

Question 15

Question 15 – A journey with a stop *(Section C · Problem solving)*

A coach leaves London at 08:00. It drives 120 km to Oxford at an average speed of 60 km/h. It stops for 30 minutes. It then travels 150 km to Birmingham at 75 km/h.

a. At what time does it reach Oxford?
b. At what time does it leave Oxford?
c. At what time does it arrive in Birmingham?
d. Find the average speed for the whole journey, including the stop.
e. Find the average speed while the coach is moving.

Question 16

Question 16 – Two trains meeting *(Section C · Problem solving)*

Two stations A and B are 280 km apart. A train leaves A at 10:00 at 90 km/h towards B. Another train leaves B at 10:00 at 50 km/h towards A on the same track (use two tracks).

a. At what speed are they getting closer to each other?
b. How long until they meet?
c. How far from A do they meet?
d. At what time do they meet?
e. How far has the second train travelled when they meet?

Question 17

Question 17 – Mixing and density *(Section C · Problem solving)*

A jeweller makes an alloy by mixing 60 cm^3 of copper (density 9.0 g/cm^3) with 40 cm^3 of zinc (density 7.0 g/cm^3).

a. Find the mass of the copper and of the zinc.
b. Find the total mass and the total volume of the alloy.
c. Find the density of the alloy.
d. The alloy is poured into a mould shaped like a cuboid 5 cm by 4 cm by 5 cm. Find its mass.

Question 18

Question 18 – Unit conversions in a recipe and a river *(Section C · Problem solving)*

A river flows at 2.5 m/s. A canal boat travels at 6 km/h in still water.

a. Convert the river speed to km/h.
b. The boat travels in the same direction as the river. What is its speed relative to the bank, in km/h?
c. How long does it take to travel 15 km downstream?
d. The boat returns against the current. What is its speed and how long does the return take?

Question 19

Question 19 – Population density of cities *(Section C · Problem solving)*

The table shows the population and area of three cities.

City	Population	Area (km²)
Leeds	800 000	552
Bristol	470 000	110
London	8 900 000	1 570

a. Find the population density of each city to the nearest whole number.
b. Which city is the most crowded?
c. How many times more crowded is Bristol than Leeds? Give 1 decimal place.
d. If Bristol's area grew to 150 km² with the same population, what would its density become?

Question 20

Question 20 – Challenge: the gold coin *(Section D · Challenge)*

A museum has a gold-coloured coin that has a mass of 38.6 g. It is thought to be pure gold (density 19.3 g/cm³). The coin is a cylinder of radius 1.2 cm and thickness 0.3 cm.

a. Find the volume of the coin to 3 decimal places.
b. Find the density of the coin to 1 decimal place.
c. Is the coin pure gold? Explain.
d. What mass would a pure gold coin of the same size have?
e. The coin is plated: pure gold on the outside and cheaper metal inside. Explain why the density tells us it is not all gold.