Worksheet - Compound units and direct/inverse proportion

Year: Year 10 · 20

Show your working.

Question 1

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

Use $\text{speed} = \dfrac{\text{distance}}{\text{time}}$ to answer these. Give answers to 1 decimal place if they are not exact.

a. A coach travels 150 miles in 2.5 hours. Find its average speed.
b. A cyclist rides at 18 km/h for 2 hours 20 minutes. How far does she ride?
c. A train travels 240 km at 80 km/h. How long does it take?
d. Change 72 km/h into metres per second.

Question 2

Question 2 – Density *(Section A · Skills practice)*

Use $\text{density} = \dfrac{\text{mass}}{\text{volume}}$. Answer each part.

a. A metal block has mass 540 g and volume 200 cm³. Find its density.
b. A liquid has density 0.8 g/cm³. What is the mass of 250 cm³ of it?
c. A lump of metal of density 8 g/cm³ has a mass of 1.2 kg. Find its volume.
d. Write the density in part (a) in kg/m³.

Question 3

Question 3 – Pressure *(Section A · Skills practice)*

Use $\text{pressure} = \dfrac{\text{force}}{\text{area}}$, with force in newtons (N) and area in square metres (m²) or square centimetres (cm²).

a. A force of 600 N acts on an area of 0.4 m². Find the pressure in N/m².
b. The pressure is 25 N/cm² and the area is 12 cm². Find the force.
c. A force of 840 N produces a pressure of 3500 N/m². Find the area.
d. A force of 90 N acts on an area of 15 cm². Find the pressure in N/cm².

Question 4

Question 4 – Direct proportion *(Section A · Skills practice)*

Use the unitary method (find the value of one first).

a. 5 pens cost £3.45. Find the cost of 8 pens.
b. A recipe for 4 people uses 280 g of pasta. How much is needed for 10 people?
c. A car uses 6 litres of petrol for 75 km. How far can it go on 10 litres?
d. 7 notebooks cost £9.45. How many notebooks can be bought for £20, and how much change is left?

Question 5

Question 5 – Inverse proportion *(Section A · Skills practice)*

In inverse proportion, when one quantity is multiplied by a number, the other is divided by it. Total work stays the same.

a. 6 workers take 10 days to build a wall. How long would 4 workers take?
b. 8 pumps empty a pool in 9 hours. How long would 12 pumps take?
c. A bag of seed feeds 20 birds for 15 days. How many days would it last 25 birds?
d. Explain why 3 workers cannot take exactly half the time of 6 workers.

Question 6

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

Non-calculator. Convert these compound units. Show your working.

a. 5 m/s into km/h
b. $1.5\ \mathrm{g/cm^3}$ into kg/m³
c. 36 km/h into m/s
d. $250\ \mathrm{N/cm^2}$ into N/m²

Question 7

Question 7 – The cycle race *(Section B · Real-life practice)*

In a charity bike ride Tomasz cycled the first 30 km in 1.5 hours and the second part, 20 km, in 0.5 hours.

Part	Distance	Time
First	30 km	1.5 h
Second	20 km	0.5 h

a. Find his average speed for each part.
b. Find his average speed for the whole ride.

c. Chloe says, “His average speed is the mean of the two speeds.” Show that she is wrong.
d. Tomasz wants to complete a 75 km ride in 3 hours. What average speed does he need?

Question 8

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

A train leaves Leeds at 09:15 and arrives in London at 11:45. The distance is 190 miles. Calculator allowed.

a. How long does the journey take, in hours?
b. Find the average speed to the nearest mph.
c. A slower train takes 3 hours 10 minutes for the same journey. What is its average speed to the nearest mph?
d. How many minutes quicker is the faster train?

Question 9

Question 9 – Gold bars *(Section B · Real-life practice)*

Gold has a density of 19.3 g/cm³. A gold bar measures 10 cm by 5 cm by 2 cm. Calculator allowed.

a. Find the volume of the bar.
b. Find the mass of the bar in grams and in kilograms.
c. Gold is worth £50 per gram. What is the value of the bar?
d. A gold-coloured bar of the same size has a mass of 800 g. Find its density and say whether it could be pure gold.

Question 10

Question 10 – Population density *(Section B · Real-life practice)*

Population density is the number of people per square kilometre. Data for three places are shown.

Place	Population	Area (km²)
Ashby	54 000	36
Barnfield	12 600	90
Corton	880 000	400

a. Find the population density of each place.
b. Which place is most crowded?
c. A new town is planned with density 1200 people/km² and an area of 25 km². How many people will live there?
d. Barnfield’s population grows by 20% but its area does not change. Find the new

density.

Question 11

Question 11 – Standing on one heel *(Section B · Real-life practice)*

Mrs Okoye weighs 600 N. When she stands on both feet in trainers her weight is spread across a total area of 400 cm². When she stands on one stiletto heel the area in contact with the floor is 1 cm².

a. Work out the pressure in N/cm² when she stands in trainers.
b. Work out the pressure under one stiletto heel.
c. How many times bigger is the pressure under the heel?
d. Explain why a stiletto heel can damage a wooden floor but trainers do not.

Question 12

Question 12 – Scaling a recipe *(Section B · Real-life practice)*

A recipe for 8 cookies uses the ingredients below. Calculator allowed.

Ingredient	Amount for 8 cookies
Butter	120 g
Sugar	90 g
Flour	180 g
Eggs	1

a. Find the amount of each ingredient for 20 cookies.
b. A pack of butter is 250 g. How many cookies can be made from one pack?
c. Layla has 500 g of flour. What is the most number of whole cookies she can make?
d. Layla has only 3 eggs. Does this limit her? Explain.

Question 13

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

A car uses 6.4 litres of petrol per 100 km. A family drives 450 km to the coast. Petrol costs £1.52 per litre.

a. How much petrol is needed for the journey?
b. Work out the cost of the petrol.
c. The journey takes 5 hours 30 minutes including a half-hour break. Find the average speed while driving, to 1 d.p.
d. Find the cost per kilometre in pence, to 1 d.p.

Question 14

Question 14 – Painting the fence *(Section B · Real-life practice)*

It takes 4 people 6 hours to paint a long fence. Each person works at the same speed and is paid £12 per hour.

a. How many hours would 3 people take?
b. How many hours would 8 people take?
c. Find the total wage bill for 4 people, and for 8 people.
d. What do you notice about the two wage bills? Explain.

Question 15

Question 15 – There and back *(Section C · Problem solving)*

Sara cycles from home to a lake 36 km away at 12 km/h. She returns by the same road at 18 km/h.

a. Work out how long each part of the trip takes.
b. Work out her average speed for the whole round trip.
c. Sara says, “The mean of 12 and 18 is 15, so my average is 15 km/h.” Explain her mistake.
d. What speed would she need on the return to average 16 km/h for the whole trip?

Question 16

Question 16 – Density of an alloy *(Section C · Problem solving)*

An alloy is made by melting 300 g of copper (density 8.9 g/cm³) with 100 g of tin (density 7.3 g/cm³).

a. Work out the volume of the copper, to 2 decimal places.
b. Work out the volume of the tin, to 2 decimal places.
c. Find the total mass and volume of the alloy.
d. Find the density of the alloy to 2 decimal places and explain why it is between the two densities.

Question 17

Question 17 – Fuel economy abroad *(Section C · Problem solving)*

UK drivers measure fuel use in miles per gallon (mpg). A family buys a car that does 45 mpg. Use: 1 gallon $= 4.546$ litres and 1 mile $= 1.609$ km.

a. How many kilometres does the car go on one gallon?
b. How many kilometres per litre is that, to 1 d.p.?
c. How many litres per 100 km, to 1 d.p.?
d. On a 600 km trip how many litres are used, and what is the cost at £1.50 per

litre?

Question 18

Question 18 – Higher: pendulums *(Section C · Problem solving)*

Higher tier. The time T seconds for one swing of a pendulum is directly proportional to the square root of its length L metres: $T \propto \sqrt{L}$. When $L = 1$, $T = 2$.

a. Write the formula $T = k\sqrt{L}$ and find k.
b. Find T when $L = 0.64$.
c. Find L when $T = 5$.
d. By what factor does T change when L is multiplied by 4?

Question 19

Question 19 – Higher: inverse square *(Section C · Problem solving)*

Higher tier. The brightness I of a lamp is inversely proportional to the square of the distance d metres from it: $I = \dfrac{k}{d^2}$. At 2 m the brightness is 36 units.

a. Find k.
b. Find the brightness at 3 m.
c. At what distance is the brightness 9 units?
d. Describe what happens to the brightness if the distance is doubled.

Question 20

Question 20 – Challenge: average speed trap *(Section D · Challenge)*

Jamal wants to drive 2 miles and average 60 mph. After the first mile he checks his watch and sees that he drove it at 30 mph.

a. How long (in minutes) did the first mile take?
b. How long should the whole 2 miles take to average 60 mph?
c. Show that it is impossible for Jamal to average 60 mph however fast he drives the second mile.
d. What average speed could he reach if he drives the second mile at 90 mph?