Answers - Speed, density and compound units

Year: Year 8

Answer to Question 1

a. Speed = distance ÷ time: $150 \div 2.5 =$**60 km/h**.
b. Distance = speed × time: $18 \times 3 =$**54 km**.
c. Time = distance ÷ speed: $90 \div 45 =$**2 hours**.
d. Metres and seconds give m/s: $400 \div 50 =$**8 m/s**.

In each case the units of the answer come from the units used: km and hours give km/h, metres and seconds give m/s.

Answer to Question 2

There are 60 minutes in an hour, so divide minutes by 60 to get a decimal of an hour and multiply the decimal part of an hour by 60 to get minutes.

a. $45 \div 60 = 0.75$, so **2.75 hours**
b. $0.4 \times 60 = 24$, so **3 h 24 min**
c. 1 h 40 min $= 1\frac{2}{3}$ h. $85 \div \frac{5}{3} =$ **51 mph**
d. $27 \div 18 = 1.5$ h = **1 h 30 min**

Answer to Question 3

a. 1 km = 1 000 m and 1 hour = 3 600 s: $72 \times 1000 \div 3600 =$**20 m/s**.
b. Multiply by 3.6: $15 \times 3.6 =$**54 km/h**.
c. Divide by 3.6: $90 \div 3.6 =$**25 m/s**.
d. $8 \times 3.6 =$**28.8 km/h**.

Dividing by 3.6 is the same as multiplying by 1 000 and dividing by 3 600; m/s values are always smaller numbers than the matching km/h values.

Answer to Question 4

a. Total 150 km in 2.5 h: **60 km/h**
b. Total 32 km in 1.5 h: $32 \div 1.5 =$ **21.3 km/h**
c. Distances: $18 + 6 = 24$ km in 3 h: **8 km/h**
d. The runner spends more time at 9 km/h, so the average speed is closer to 9 than to 6; the simple mean 7.5 would ignore the times.

Answer to Question 5

a. Density = mass ÷ volume: $540 \div 200 =$**2.7 g/cm³** (the density of aluminium).
b. Mass = density × volume: $8 \times 35 =$**280 g**.
c. Volume = mass ÷ density: $750 \div 1.5 =$**500 cm³**.
d. Volume of the cube $5^3 = 125$ cm³, so density $1000 \div 125 =$**8 g/cm³**.

Answer to Question 6

a. Rate = amount ÷ time: $120 \div 8 =$**15 litres per minute**.
b. People ÷ area: $36000 \div 40 =$**900 people per km²**.
c. Miles ÷ litres: $60 \div 5 =$**12 miles per litre**.
d. Each mile uses $\frac{1}{12}$ litre, so costs $140 \div 12 =$**11.7p per mile**.

The word “per” tells you which quantity to divide by.

Answer to Question 7

a. 11:25 minus 09:10 = **2 h 15 min**
b. $2 + \frac{15}{60} =$ **2.25 hours**
c. $200 \div 2.25 =$ **88.9 mph**
d. $1\text{ h }55\text{ min} = 1.9167$ h. $200 \div 1.9167 = 104.3$ mph. It is about **15.4 mph faster**.

Writing 2 h 15 min as 2.25 hours, not 2.15, is the key step: 15 minutes is a quarter of an hour.

Answer to Question 8

a. 27.5 min $= 27.5 \div 60 =$ **0.4583 h**
b. Ella: $5 \div 0.4583 =$ **10.9 km/h**. Raj: $5 \div 0.4 =$ **12.5 km/h**.
c. Ella's speed $= 10.909$ km/h $= 3.03$ m/s. In 24 min $= 1440$ s she runs 4364 m, so she is **636 m behind**.
d. $5 \div \frac{25}{60} =$ **12 km/h**

Answer to Question 9

a. $4.8 \div 16 = 0.3$ h = **18 min**
b. $4.8 \div 12 = 0.4$ h = **24 min**
c. Total distance 9.6 km in 0.7 h: $9.6 \div 0.7 =$ **13.7 km/h**
d. No. The round trip takes longer at the slower speed, so the average is **13.7 km/h**, not 14.

The slower journey takes longer, so it counts for more in the average; this is why the round-trip average is below 14 km/h.

Answer to Question 10

a. $1260 \div 630 =$ **2 hours**
b. 06:50 + 2 h = **08:50**
c. $1260 \div 540 = 2.33$ h = **2 h 20 min**
d. Total 2520 km in 4.33 h: **582 km/h** (to the nearest whole number).

The average speed for the round trip uses the total distance and the total time, not the average of 630 and 540.

Answer to Question 11

a. Aluminium: $405 \div 150 =$ **2.7**. Iron: $630 \div 80 =$ **7.875**. Gold: $965 \div 50 =$ **19.3**.
b. Aluminium and iron are less dense than mercury, so they **float**; gold (19.3) is more dense, so it **sinks**.
c. $19.3 \times 1000 = 19300$ g = **19.3 kg**
d. $19.3 \div 2.7 = 7.15$, so **yes**, about 7 times.

Answer to Question 12

a. Volume = length × width × depth: $25 \times 10 \times 1.8 = 450$ m³, which is **450 000 litres**.
b. $450000 \div 5000 = 90$ minutes, which is **1 h 30 min**.
c. $450 \times 1.80 =$**£810**.
d. A day has $24 \times 60 \times 60 = 86400$ s: $4 \times 86400 = 345600$ litres, which is **345.6 m³**.

Answer to Question 13

a. A: $240 \div 5 =$ **48 mpg**. B: $240 \div 6.4 =$ **37.5 mpg**.
b. A: $5 \times 6.30 =$ **£31.50**. B: $6.4 \times 6.30 =$ **£40.32**.
c. **Car A** is cheaper by $40.32 - 31.50 =$ **£8.82**.
d. $12 \times 37.5 =$ **450 miles**

Miles per gallon is distance ÷ fuel used; the higher the mpg, the cheaper the car is to run.

Answer to Question 14

a. 4 km in 1 h: **4 km/h**

b. Flat part from 1 h to 3 h: **2 hours**
c. 4 km in 2 h (from 3 h to 5 h): **2 km/h**
d. Total distance 8 km in 5 h: **1.6 km/h**

Answer to Question 15

a. $120 \div 60 = 2$ h, so **10:00**
b. Stop for 30 min: **10:30**
c. $150 \div 75 = 2$ h, so **12:30**
d. Total distance 270 km in 4.5 h: **60 km/h**
e. Moving time $= 4$ h: $270 \div 4 =$ **67.5 km/h**

Including the 30-minute stop lowers the average speed, because the coach covers no distance during that time.

Answer to Question 16

a. Moving towards each other, their speeds add: $90 + 50 =$**140 km/h**.
b. The gap of 280 km closes at 140 km/h: $280 \div 140 =$**2 hours**.
c. The first train travels $90 \times 2 =$**180 km** from A.
d. Two hours after 10:00: **12:00**.
e. $50 \times 2 =$**100 km**, and $180 + 100 = 280$ km, the full distance.

Answer to Question 17

a. Mass = density × volume. Copper $9 \times 60 =$**540 g**, zinc $7 \times 40 =$**280 g**.
b. Total mass $540 + 280 =$**820 g**; total volume $60 + 40 =$**100 cm³**.
c. Density = total mass ÷ total volume: $820 \div 100 =$**8.2 g/cm³**, between the two metals as expected.
d. The mould has volume $5 \times 4 \times 5 = 100$ cm³, so the mass is $8.2 \times 100 =$**820 g**.

Answer to Question 18

a. Multiply by 3.6: $2.5 \times 3.6 =$**9 km/h**.
b. Going with the current, the speeds add: $6 + 9 =$**15 km/h**.
c. Time = distance ÷ speed: $15 \div 15 =$**1 hour**.
d. Against the current the speeds subtract: $6 - 9 = -3$ km/h. The boat is pushed backwards, so it **cannot** travel upstream.

Answer to Question 19

a. Density = population ÷ area. Leeds $800000 \div 552 \approx$**1 449**, Bristol $470000 \div 110 \approx$ **4 273**, London $8900000 \div 1570 \approx$**5 669** people per km².
b. The highest density is **London**, although Bristol is close behind.
c. $4273 \div 1449 \approx$**2.9 times** as crowded.
d. $470000 \div 150 \approx$**3 133** people per km²; a larger area with the same population lowers the density.

Answer to Question 20

a. $\pi \times 1.2^2 \times 0.3 =$ **1.357 cm³**
b. $38.6 \div 1.357 =$ **28.4 g/cm³**
c. 28.4 is greater than 19.3, so it is **not** pure gold; it must contain a metal denser than gold (or the measurements are wrong).
d. $19.3 \times 1.357 =$ **26.2 g**
e. The measured mass is greater than the pure gold mass of 26.2 g, so it must contain something denser than gold; the density test shows that the coin is not simply gold.