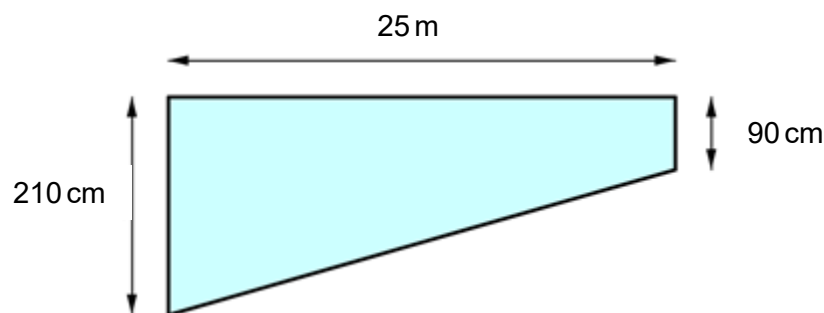


## Higher Check In - 10.01 Units and measurement

1. How many minutes are equivalent to 2.25 hours?
2. An object travels with speed  $6(x + 7)$  km/h. Find  $x$  when the object is travelling at 25 m/s.
3. Simplify the ratio 1.2 km : 400 m.
4. Which contains more liquid: thirteen 330 ml cans or three 1.5 litre bottles?
5. A map is drawn at 1 : 50 000 scale. Jenny walks along a section of Roman road that measures 3 cm long on the map. It takes her 30 minutes. What is her average speed in km/h?
6. Water is most dense at approximately  $4^{\circ}\text{C}$ . At this temperature its density is  $1.000\text{ g/cm}^3$ . Show that  $56\text{ m}^3$  of water weighs 56 000 kg.
7. In the UK, the speed limit when driving a heavy goods vehicle on a motorway is 60 miles per hour. In New Zealand, it is 90 kilometres per hour. Using the fact that 5 miles is approximately 8 kilometres, explain which country has the higher speed limit for heavy goods vehicles.
8. The fastest a human has ever been recorded running was Usain Bolt in 2009 at 12.4 metres per second. If humans had to obey a 30 mph (48 km/h) speed limit, is it possible for us to break the law by running too fast?
9. A swimming pool is 10 m wide and 25 m long. The cross-section of the pool is in the shape of a trapezium as shown in the diagram. The pool is full of water at a temperature of  $28^{\circ}\text{C}$  which has density  $0.9961\text{ g/cm}^3$ . Work out the mass of water in the pool in metric tonnes (where 1 tonne = 1000 kg).



10. In 2001, the total amount of gold that was mined in the world was 2600 tonnes (where 1 tonne = 1000 kg). The density of gold is  $19.30\text{ g/cm}^3$ . If all the gold mined in 2001 was melted down and formed into a cube, how long would the sides of the cube be?

### Extension

When you sit your GCSE Mathematics exam, roughly how many times will your heart have beaten since you were born? It may be helpful to know that typical heart rates for children are between 60 and 150 beats per minute.

# GCSE (9–1)

# MATHEMATICS

## Answers

- $2.25 \times 60 = 135$  minutes
- $25 \div 1000 \times 3600 = 90$  km/h.  $6(x + 7) = 90$ ,  $x + 7 = 15$ , so  $x = 8$
- $1200 \text{ m} : 400 \text{ m} = 3 \text{ m} : 1 \text{ m} = 3 : 1$
- $13 \times 330 \text{ ml} = 4290 \text{ ml} = 4.29$  litres,  $3 \times 1.5 = 4.5$  litres so three bottles contain more liquid (0.21 litres or 210 ml more).
- 3 cm on the map is  $3 \times 50000 = 150000$  cm in the real world. Dividing by 100 (to convert into m) then 1000 (to convert to km), means she walks 1.5 km.  
Speed = distance  $\div$  time =  $1.5 \times 0.5 = 3$  km/h.
- Converting  $56 \text{ m}^3$  into  $\text{cm}^3$  by multiplying by  $100^3$  gives  $56\,000\,000 \text{ cm}^3$ . Dividing by the density of 1 gives a mass of  $56\,000\,000 \text{ g}$ . Dividing by 1000 to convert to kg gives  $56\,000 \text{ kg}$ .
- If 5 miles = 8 km, then 60 miles = 96 km.  $96 \text{ km/h} > 90 \text{ km/h}$  so the UK has a higher speed limit for HGVs. Alternatively,  $90 \text{ km/h}$  is approximately 56 mph.
- Multiplying by  $60 \times 60 = 3600$  converts  $12.4 \text{ m/s}$  to  $44640 \text{ m/h}$ . Dividing by 1000 converts this to  $44.64 \text{ km/h}$ . If Usain Bolt would be unable to run faster than the  $48 \text{ km/h}$  speed limit, it is doubtful that anyone could.
- Working initially in m and kg,  $0.9961 \text{ g/cm}^3 = 996.1 \text{ kg/m}^3$ .  
The area of the pool's cross-section is  $\frac{1}{2}(2.1 + 0.9) \times 25 = 37.5 \text{ m}^2$ .  
The volume of the pool is  $37.5 \times 10 = 375 \text{ m}^3$ .  
The mass of the water is  $375 \times 996.1 = 373537.5 \text{ kg}$ , or approximately 373.5 metric tonnes.
- The mass of the gold is  $2600 \times 1000 = 2600000 \text{ kg}$ . The density of gold is  $19300 \text{ kg/m}^3$  (by  $\times 100^3$  to convert from  $\text{cm}^3$  to  $\text{m}^3$ , then  $\div 1000$  to convert from g to kg).  $v = m \div d = 2600000 \div 19300 = 134.7 \text{ m}^3$ . A cube of side length  $x$  needs to have volume  $x^3 = 134.7$  so  $x = \sqrt[3]{134.7} \approx 5.1 \text{ m}$ .

## Extension

Assuming you sit your exam on your 16th birthday, and your heart rate is in the middle of the stated range at 105 beats per minute, you have been alive for  $16 \times 365.25 \times 24 \times 60 = 8415360$  minutes.

Your heart will have beaten  $105 \times 8415360 \approx 880000000$  times, or nearly 1 billion times! (Any answer between about half a billion and one billion would be a reasonable estimate.)

# GCSE (9–1)

# **MATHEMATICS**

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Assessment Objective	Qu.	Topic	R	A	G
AO1	1	Use and convert standard units of time			
AO1	2	Use and convert compound units in algebraic contexts			
AO1	3	Simplify ratio involving standard units of length			
AO1	4	Use and convert standard units of volume/capacity			
AO1	5	Use the scale of a map and apply speed = distance ÷ time			
AO2	6	Use and convert density, knowing that density = mass ÷ volume			
AO2	7	Use and convert speed			
AO2	8	Use and convert speed			
AO3	9	Solve problem involving volume and density			
AO3	10	Solve problem involving mass, density and volume			

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