GCSE Maths – Ratio, Proportion and Rates of Change

Standard and Compound Units

Worksheet

WORKED SOLUTIONS

This worksheet will show you how to work out different types of standard and compound units' questions. Each section contains a worked example, a question with hints and then questions for you to work through on your own.

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Section A

Worked Example

Umar runs 5,200 metres every day. Work out how far Umar runs in 5 days in kilometres.

Step 1: Find the conversion for metres to kilometres.

$$m \rightarrow \div 1000 \rightarrow km$$

Step 2: Calculate the value in kilometres.

$$5200 \div 1000 = 5.2$$

Umar runs 5.2 km a day

Step 3: Calculate the distance ran in 5 days.

$$5.2 \times 5 = 26$$

Umar runs 26 km in 5 days.

Guided Example

Tanisi is 5 feet and 3 inches tall. Saloni is 169 cm tall. Tanisi says "I am the taller one". Is she correct?

Step 1: Convert all values to 1 unit.
Change all values to cm

Step 2: Use ratios to convert 5 feet to the chosen common unit.

$$1\ foot = 30\ cm$$
$$5\ ft = \underline{150}\ cm$$

(x5 and x5)

Step 4: Use ratios to convert 3 inches to the chosen common unit.

$$1\ inch = 2.5\ cm$$
$$3\ inches = \underline{7.5}\ cm$$

(x3 and x3)

Step 5: Add these heights together to calculate Tanisi's height in centimetres. Compare Tanisi's and Saloni's heights.

$150 + 7.5 = 157.5$ cm ← Tanisi's height

Tanisi is wrong, Saloni is taller as 169 cm > 157.5 cm

Now it's your turn!
If you get stuck, look back at the worked and guided examples.

1. Convert 0.02 kilometres to centimetres

km $\xrightarrow{\times 1000}$ m $\xrightarrow{\times 100}$ cm

$0.02 \times 1000 = 20\text{m}$

$20 \times 100 = 2000\text{cm}$

0.2km = 2000cm

2. Convert 45 feet to yards ($3\ feet = 1\ yard$)

3ft = 1 yard

$\div 15$ ↓ ↑ $\times 15$

45ft = 15 yards

45 feet = 15 yards

3. Ross travels 36 km from Birmingham to Coventry. He then drives 120 miles to London. Calculate the total distance Ross travels in miles. ($5\ miles = 8\ km$)

As the question asks for the distance in miles, convert all distances to miles.

5 miles = 8 km

$\times \frac{9}{2}$ ↓ ↑ $\div 9/2$

22.5 miles = 36 km

Total Distance: $22.5 + 120 = 142.5$

142.5 miles

4. Rachel and Phoebe go running. Rachel runs 1km to Phoebe's house and together they run 5 miles. Rachel then runs back home. How many kilometres does Rachel run? ($5\ miles = 8\ km$)

$1 + 1 = 2\text{km}$ (to and fro Phoebe's house)

5 miles = 8km (they run 8km together)

Total: $2 + 8 = 10\text{km}$

Rachel runs a total of 10km.

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Section B

Worked Example

Convert 760 mm^2 to cm^2

Step 1: Convert mm^2 to cm^2.

$$mm^2 \rightarrow \div 100 \rightarrow cm^2$$

Step 2: Calculate the required value.

$$760 \div 100 = 7.6$$
$$760\ mm^2 = 7.6\ cm^2$$

Guided Example

Convert 21cm^3 to mm^3

Step 1: Convert cm^3 to mm^3.

cm $\xrightarrow{\times 10}$ mm

cm^3 $\xrightarrow[(\times 1000)]{\times 10^3}$ mm^3

Step 2: Calculate the required value.

$21\ cm^3 \times 1000 = 21000\ mm^3$

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Now it's your turn!
If you get stuck, look back at the worked and guided examples.

5. Convert 3232 cm^2 to m^2

$cm \xrightarrow{\div 100} m$

$cm^2 \xrightarrow[(\div 10000)]{\div 100^2} m^2$

$3232 \div 10000 = 0.3232\ m^2$

6. Convert 9245 mm^3 to cm^3

$mm \xrightarrow{\div 10} cm$

$mm^3 \xrightarrow[(\div 1000)]{\div 10^3} cm^3$

$9245 \div 1000 = 9.245\ cm^3$

7. Convert 0.003 m^2 to mm^2

$m \xrightarrow{\times 1000} mm$

$m^2 \xrightarrow[(\times 1000\,000)]{\times 1000^2} mm^2$

$0.003 \times 1000000 = 3000\ mm^2$

8. A triangle's area is 12000 cm^2. What is the area in m^2?

$cm \xrightarrow{\div 100} m$

$cm^2 \xrightarrow[(\div 10000)]{\div 100^2} m^2$

$12{,}000 \div 10{,}000 = 1.2\ m^2$

9. The volume of a box is 3000000 cm^3. What is the volume in m^3?

$cm \xrightarrow{\div 100} m$

$cm^3 \xrightarrow[(\div 1000000)]{\div 100^3} m^3$

$3000000 \div 1000000 = 3\ m^3$

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Section C

Worked Example

Charles pours lemonade out of a 1 litre jug. His cup holds 300 ml and he fills his cup exactly halfway. How much lemonade is left in the jug in ml?

Step 1: Convert the capacity of lemonade into millilitres.

$$litres \rightarrow \times 1000 \rightarrow ml$$

There is 1000 ml of lemonade in the 1 litre jug.

Step 2: Calculate how much lemonade is poured into Charles' glass.

$$300 \div 2 = 150$$

Charles pours 150 ml out of the jug

Step 3: Calculate the remaining capacity.

$$1000 - 150 = 850$$

There is 850 ml of lemonade left in the jug.

Guided Example

Amy donates 30 pints of milk to Food Aid. Jake donates 3 gallons of milk. Who donates more milk?

1. Convert all values to a chosen common unit.

   Change all values to pints

2. Use ratios to convert 3 gallons to pints.

$$8\ pints = 1\ gallon$$

$\times 3$ ↓ ↑ $\div 3$

$$24\ pints = 3\ gallons$$

3. Work out who donates more milk.

30 pints > 24 pints. Amy donates more milk.

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Now it's your turn!
If you get stuck, look back at the worked and guided examples.

10. Convert 4000 ml to cm^3

$1\ ml = 1\ cm^3$ (×4000) → $4000\ ml = 4000\ cm^3$ (÷4000)

$4000\ cm^3$

11. Convert 9 litres to gallons

$1\ gallon \approx 4.5\ l$ (×2) → $2\ gallon \approx 9\ l$ (÷2)

2 gallons

12. Rosa is having a party. She mixes 4 litres of Apple Juice with 1800 ml of Mango Juice and 500 ml of Orange Juice. What is the total capacity of her drink?

Convert all to ml:

$1\ l = 1000\ ml$ (×4) → $4\ l = 4000\ ml$ (÷4)

Total capacity $= 4000 + 1800 + 500$

$= 6300\ ml$ or $6.3\ l$

13. Terry is mixing paint to make a specific colour of teal. He mixed 1 gallon of dark blue with 1.9 litres of Green Paint and 1140 ml of White Paint. He needs 7.5 litres of paint to cover his walls. Will Terry have enough paint?

Convert all to litres.

1 gallon = 4.5 litres (dark blue)

ml → (÷1000) → l

$1140 \div 1000 = 1.14\ l$ (white)

$4.5 + 1.14 + 1.9 = 7.54$

Terry uses $7.54\ l$ of paint, $7.54 > 7.5$.

Therefore Terry has enough paint.

14. Kevin and Ray are at a farm, milking cows. Kevin milks 6.75 litres and Ray milks 11 pints. Who milks more?

Converting to pints

$1\ l \approx 1.76$ pints (×6.75) → $6.75\ l \approx 11.88$ pints (÷6.75)

$11.88 > 11$

Kevin milks more.

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Section D

Worked Example

Gina receives an order weighing 1.9 kg. Another parcel arrives weighing 980 grams. What is the total mass of Gina's packages?

Step 1: Convert mass from kilograms to grams.

$$kg \rightarrow \times 1000 \rightarrow g$$

The first order has a mass of 1900 g.

Step 2: Calculate the total mass of Gina's packages.

$$1900 + 980 = 2880\ g$$

The total mass of the packages is 2880 grams.

Guided Example

Doug is going on holiday and is travelling with 2 suitcases. The first suitcase weighs 9.5 kg, and the second suitcase weighs 3500 g. There is a 15 kg total limit, does Doug exceed the limit?

Step 1: Convert mass from grams to kilograms.

g $\xrightarrow{\div 1000}$ kg

$3500 \div 1000 = 3.5$

The second suitcase has a mass of 3.5 *kg.*

Step 2: Calculate the total mass of Doug's luggage.

$9.5 + 3.5 = 13$ kg

Step 3: Evaluate whether the luggage exceeds the limit.

$13 < 15$

Therefore Doug does not exceed the limit.

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Now it's your turn!
If you get stuck, look back at the worked and guided examples.

15. Convert 45 ounces to grams ($28\ g = 1\ ounce$)

28g = 1 ounce
×45 ↓ ÷45
1260g = 45 ounces

1260g

16. Convert 3 stones to grams ($6.4\ kg = 1\ stone$)

6.4 kg = 1 stone
×3 ↓ ÷3
19.2 kg = 3 stones

kg ×1000 → g

19.2 × 1000 = 19200g

17. Scully weighs 19.5 stones. Hitchcock weighs 120 kg. Who weighs more and by how much? ($6.4\ kg = 1\ stone$)

6.4kg = 1 stone
124.8kg = 19.5 stones

Difference: 124.8 − 120 = 4.8

124.8 > 120

Scully weighs more by 4.8kg

18. Madeleine buys some vegetables. She buys 1.5 kg of potatoes, 400g of tomatoes, 2390 grams of onions and butternut squash weighing 1.1 kg. She carries them with 2 bags. Each bag can hold a mass of up to 2500 grams. Will Madeleine be able to carry the vegetables with 2 bags?

2 bags can hold: 2 × 2500 = 5000g

kg ×1000 → g

1.5 × 1000 = 1500g
1.1 × 1000 = 1100g

Total weight:
1500 + 1100 + 2390 + 400 = 5390

5390g > 5000g

Madeleine will not be able to hold all the vegetables with 2 bags.

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19. A lift can hold up to 65 kg. There are 8 people in this lift and each person weighs 10 stones on average. Will the lift be able to carry the weight of all 8 people? $(6.4\ kg = 1\ stone)$

Total weight of the people: $8 \times 10 = 80$ stones

6.4 kg $= 1$ stone

$\times 80$ ↓ ↑ $\div 80$

512 kg $= 80$ stones

512 kg > 65 kg

The lift will not be able to carry all 8 people.

20. Cagney weighed 6.4 pounds when she was born. Lacey 100 ounces when she was born. Who weighed more at birth? $(16\ ounces = 1\ pound)$

16 ounces $= 1$ pound

$\times 6.4$ ↓ ↑ $\div 6.4$

102.4 oz $= 6.4$ pounds

$102.4 > 100$

Cagney weighed more at birth.

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Section E

Worked Example

Roger ran 500 m in 100 seconds. Calculate the speed (m/s).

Step 1: Recall the formula.

$$Speed = \frac{Distance}{Time}$$

Step 2: Substitute the values into the formula.

$$Speed = \frac{500}{100}$$

Step 3: Calculate the speed.

$$Speed = 5\ m/s$$

Roger runs at $5\ m/s$.

Guided Example

Karen travels at 68 mph. Katy travels 100 km in 1 hour and 15 minutes. Who travels faster?

Step 1: Convert time to hours.

$1\ hour\ 15\ min =$ 1.25 hours

1 + 0.25

15 ÷ 60 = 0.25h

Step 2: Calculate Katy's speed.

$$Speed = \frac{Distance}{Time}$$

5 miles = 8 km

× 12.5 → 62.5 miles = 100 km ← ÷ 12.5

$$speed = \frac{62.5\ mile}{1.25}$$

$= 50\ mph$

Step 3: Compare Karen's and Katy's speed.

50 < 68

Karen travels faster.

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Now it's your turn!
If you get stuck, look back at the worked and guided examples.

21. Sophia ran a 750 m race at 25 km/h. Olivia ran at 7 m/s. Who won the race?

Convert km/h to m/s

1000m = 1 km ← like ×1

$$\frac{25\,\text{km}}{1\,\text{hour}} \times \frac{1000\,\text{m}}{1\,\text{km}} \times \frac{1\,\text{hour}}{3600\,\text{sec}}$$ units cancel

↳ 60 × 60 = 3600 sec

$$\frac{25 \times 1000\,\text{m}}{3600\,\text{s}} = \frac{250}{36}\,\text{m/s} \approx 6.94\,\text{m/s}$$

$6.94 < 7$

Olivia ran faster, therefore she won the race.

22. David travels from London to Birmingham, which is approximately 100 miles. He leaves at 8 am and travels at an average speed of 65 mph. What time does David arrive in Birmingham?

$$\text{Time} = \frac{\text{Distance}}{\text{Speed}}$$

$$\text{Time} = \frac{100}{65} = 1.538\ldots\,\text{h}$$

$1.538\ldots\,\text{h} \times 60 \approx 92\,\text{min}$

8am + 92 min :

8am + 60 min = 9am

9am + 32 min = 9:32am

David reaches Birmingham at 9:32am.

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23. Debbie leaves for Manchester at 10 am and arrives at 12 pm. She travels at an average speed of 70 mph. Calculate the distance Debbie travelled in kilometres.

Distance = Speed × Time

Time: 10am to 12pm = 2hours

Speed: 70mph

Distance = 2 × 70 = 140 miles.

In kilometres:

5 miles = 8 km

÷28 ↓ 140 miles = 224 km ↓ ×28

Debbie travelled 224km.

24. Ava runs at an average speed of 3.2 m/s. How long would it take her to run 20 miles in minutes?

5 miles = 8 km

÷4 ↓ 20 miles = 32 km ↓ ×4

km $\xrightarrow{\times 1000}$ m

32 × 1000 = 32000 m

$\text{Time} = \frac{\text{Distance}}{\text{Speed}}$

$\frac{32000}{3.2} = 10000$ sec

In minutes:

sec $\xrightarrow{\div 60}$ min

10000 ÷ 60 ≈ 166.7 min

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Section F

Worked Example

The mass of a $15\ m^3$ block is 45045 g. Calculate the density in kg/m^3

Step 1: Recall the formula.

$$Density = \frac{Mass}{Volume}$$

Step 2: Convert 45045g to kg.

$$45045 \div 1000 = 45.045$$

Step 3: Substitute the values into the formula.

$$Density = \frac{45.045}{1.5}$$

Step 3: Calculate the density.

$$Density = 30.03\ kg/m^3$$

Guided Example

A liquid has a mass of 5 kg and a density of $1.2\ g/cm^3$. Calculate the volume of the liquid.

Step 1: Recall the formula.

$$Density = \frac{Mass}{Volume}$$

Step 2: Convert 5 kg to g.

kg $\xrightarrow{\times 1000}$ g

$5 \times 1000 = 5000g$

Step 3: Substitute the values into the formula.

$$1.2 = \frac{5000}{Vol}$$

Step 3: Calculate the volume by rearranging the formula.

$$Volume = \frac{5000}{1.2} \approx 4167\ cm^3$$

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Now it's your turn!
If you get stuck, look back at the worked and guided examples.

25. A gnome has a volume of $0.06\ m^3$ and a density of $6.6\ g/cm^3$. Calculate the mass of the gnome.

$m^3 \xrightarrow{\times 100^3} cm^3$

Mass = Density × Volume

$0.06 \times 1000000 = 60000\ cm^3$

$\text{Mass} = 60000 \times 6.6 = 396,000\ g$

26. A glass cube has a side length of 4 cm and a mass of 12800 g. Calculate the density of the cube.

$\text{Density} = \frac{\text{Mass}}{\text{Vol}}$

$\text{Volume}: 4 \times 4 \times 4 = 64\ cm^3$

$\text{Density} = \frac{12800}{64} = 200\ g/cm^3$

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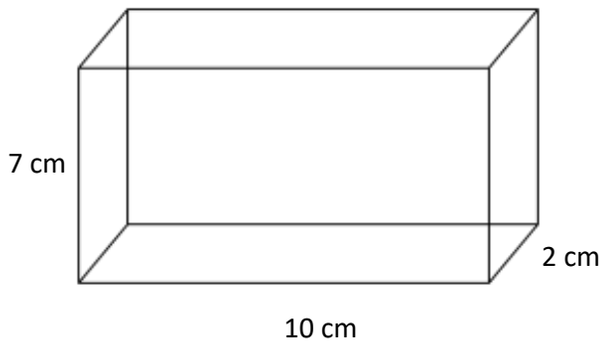
27. The mass of the cuboid is 1400 g. Calculate the density of the cuboid.



$\text{Density} = \frac{\text{Mass}}{\text{Vol}}$

$\text{Vol} = 7 \times 2 \times 10$
$= 140\ cm^3$

$\text{Density} = \frac{1400\ g}{140\ cm^3}$

$= 10\ g/cm^3$

28. The cylinder has a radius of 3 cm and a height of 8 cm. The density of the cylinder is $1.02\ g/cm^3$. Calculate the mass of the cylinder.

$\text{Density} = \frac{\text{Mass}}{\text{Vol}}$

Vol of Cyclinder: $\pi r^2 h$
$= \pi \times 3^2 \times 8 = 72\pi\ cm^3$

$\text{Mass} = 72\pi \times 1.02 = 73.44\pi$
$\approx 231\ g$

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Section G

Worked Example

A car travels 108 miles on 6 gallons of petrol. Find the miles per gallon.

Step 1: Identify what the question is asking.

"per gallon" implies that we are dividing by the number of gallons

Step 2: Calculate the miles per gallon.

$$108 \div 6 = 18$$

For every 18 miles the car travels, it uses 1 gallon. 18 miles per gallon.

Guided Example

Marcus works 100 hours and is paid £875. Calculate his wage (£ per hour).

Step 1: Identify what the question is asking.

per hour suggests we have to divide the money by the hours

Step 2: Calculate the wage.

$875 \div 100 = 8.75$

Marcus' wage is 8.75

He works £ 8.75 *per hour*

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Now it's your turn!
If you get stuck, look back at the worked and guided examples.

29. Sharon scores 35 points in five games. How much do Sharon score per game?

$\frac{35 \text{ points}}{5 \text{ games}} = 7 \text{ points per game}$

30. Jason works 140 hours and is paid £1260. Keith works at a rate of £10 per hour. Who earns more per hour?

Jason works: $\frac{£1260}{140h} = £9$ per hour.

$10 > 9$.

Keith earns more per hour.

31. One bag (①) of crisps costs 60p. Six bags (②) of crisps costs £1.50. Which has the lower unit price?

① 60p per bag

② $\frac{£1.50}{6 \text{ bags}} = £0.25$ per bag $= 25p$ per bag

$25 < 60$.

Buying 6 bags for £1.50 is cheaper.

32. Mac is buying flour. He can either buy 6 kg of flour for £5 (①) or 7 kg for £5.80 (②). Which has the lower unit price?

Unit price: £ per kg

① $\frac{£5}{6kg} \approx £0.833$ per kg

② $\frac{£5.80}{7kg} \approx £0.828$ per kg

$0.828 < 0.833$

The 7kg of flour has the lower unit price.

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