MATHS FORENSICS
CASE FILE WORKSHEET · GCSE

MF-CF-NUM-SPEED
GCSE HIGHER · ABOUT 50 MINUTES

CASE FILE SERIES · NUMBER

SPEED AND DISTANCE-TIME GRAPHS

Speed, distance and time are one formula three ways round. Secure the calculations, extend to graphs, units and average speed, then master velocity-time graphs and meeting problems.

SECURING · GRADES 4–5 | EXTENDING · GRADES 6–7 | MASTERY · GRADES 8–9

Name _____ Class _____ Date _____

CASE BRIEFING

WHAT YOU NEED TO KNOW

Speed = $\frac{\text{distance}}{\text{time}}$. Rearranged: distance = speed × time, and time = $\frac{\text{distance}}{\text{speed}}$. The units must match: km and hours give km/h; metres and seconds give m/s.

On a **distance-time graph**, the gradient is the speed and a flat section means stopped. On a **speed-time graph**, the gradient is the acceleration and the **area underneath** is the distance travelled.

1. Write the formula you need, rearranged for the unknown.
2. Check the units: convert minutes to hours, or km to m, before you calculate.
3. For a graph: read values carefully at grid lines, then use gradient or area.
4. Give units with every answer, and turn decimal hours into minutes if asked.

WORKED EXAMPLE **A patrol car drives 45 km in 36 minutes. Find its average speed in km/h.**

SOLUTION

1 The answer is in km/h, so change the time to hours: 36 minutes = $\frac{36}{60}$ = 0.6 hours.

2 Speed = $\frac{\text{distance}}{\text{time}} = \frac{45}{0.6}$.

3 = 75 km/h.

4 Check: 75 km/h × 0.6 h = 45 km ✓

✓ **75 km/h**

KNOWLEDGE CHECK

Use your investigative skills to solve each case. Show full working: the method marks are where most students lose out.

Securing
Speed, distance and time, and reading a distance-time graph.
Secured ☐

Extending
Unit conversions, density, average speed over two stages, and tampered evidence.
Secured ☐

Mastery
Velocity-time graphs, pressure, and two objects moving at once.
Secured ☐

SECURING

The method, step by step. Show every line.

1 A car travels 150 km in 2.5 hours. Find its average speed. [2]

km/h _____

2 A runner runs at 4 m/s for 90 seconds. How far does she run? [2]

m _____

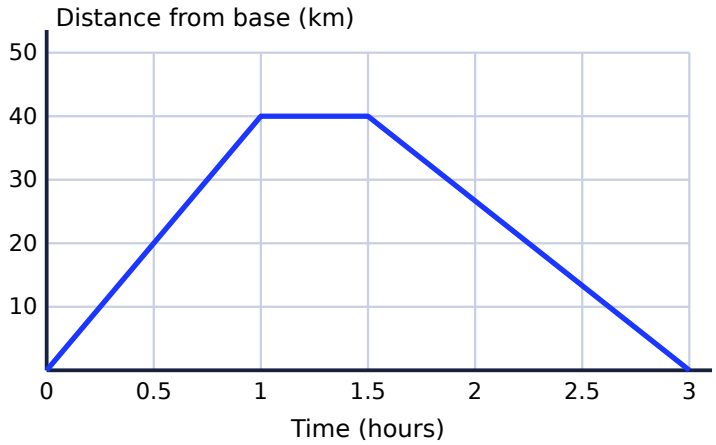
3 How long does it take to travel 210 miles at 60 mph? Give your answer in hours and minutes. [2]

___ h ___ min _____

FORENSIC TIP 0.5 hours is 30 minutes, not 50. Multiply the decimal part by 60.

4 The graph shows a detective's journey from base to a crime scene and back. [2]

Work out her speed on the way to the crime scene.



km/h _____

5 Use the graph. How long did she spend at the crime scene? [1]

minutes _____

EXTENDING A step is hidden, or there's a context to unpick. One piece of tampered evidence.

6 Use the same graph. Work out her speed on the way back to base. Give your answer to 1 decimal place. [2]

km/h _____

7 Change 72 km/h into m/s. [2]

m/s _____

8 A metal block has a mass of 240 g and a volume of 30 cm^3. Find its density. [2]

g/cm^3 _____

9 A drone flies 12 km at 30 km/h, then 18 km at 45 km/h. Find its average speed for the whole flight. [3]

km/h _____

FORENSIC TIP Average speed is total distance ÷ total time. It is **not** the average of 30 and 45.

10 Leo worked out the speed of a car that travels 45 km in 30 minutes. Find his mistake and give the correct speed. [2]

TAMPERED EVIDENCE · FIND THE MISTAKE

speed = 45 ÷ 30 = 1.5 km/h

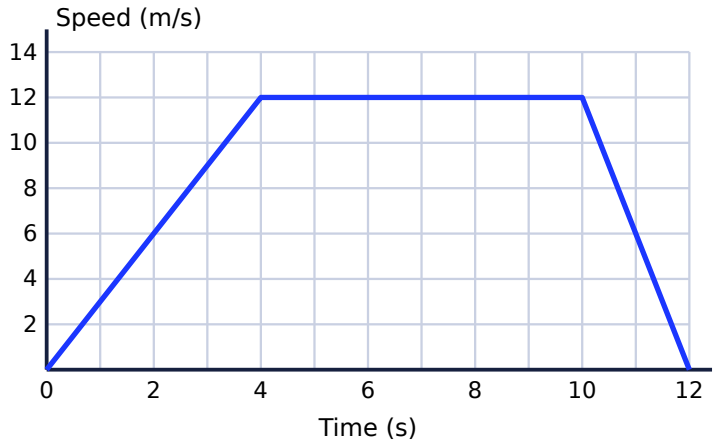
km/h _____

MASTERY

No hints. Plan before you calculate.

11 The speed-time graph shows a car pulling away from a crime scene, then stopping at a checkpoint. [3]

Work out the total distance travelled.



m _____

FORENSIC TIP Split the area under the graph into triangles and a rectangle. Distance is the **area**, not the gradient.

12 Use the speed-time graph. Work out the car's acceleration in the first 4 seconds. [2]

m/s² _____

13 A crate rests on a face of area 0.4 m², exerting a pressure of 300 N/m². [3]
It is turned onto a face of area 0.15 m². Find the new pressure.

N/m² _____

14 Two suspects are 270 km apart. They drive towards each other, starting at the same time, at 80 km/h and 100 km/h. [3]
How far has the slower car travelled when they meet?

km _____

15 A train 200 m long travels at 90 km/h through a tunnel 1.3 km long. How long does it take from the front entering to the back leaving the tunnel? [3]

seconds _____

KNOWLEDGE CHECK: SOLUTIONS

Check your method as well as your answer. In the exam, an answer with no working usually earns the final mark at most.

Q1 SECURING

✓ **60 km/h**

Q2 SECURING

✓ **360 m**

Q3 SECURING

210 ÷ 60 = 3.5 hours.

✓ **3 hours 30 minutes**

Q4 SECURING

40 km in 1 hour.

✓ **40 km/h**

Q5 SECURING

The flat section, from 1 to 1.5 hours.

✓ **30 minutes**

Q6 EXTENDING

40 km in 1.5 hours.

✓ **26.7 km/h**

Q7 EXTENDING

72 000 m in 3600 s.

✓ **20 m/s**

Q8 EXTENDING

Density = mass ÷ volume.

✓ **8 g/cm³**

Q9 EXTENDING

Times 0.4 h + 0.4 h = 0.8 h. 30 km ÷ 0.8 h.

✓ **37.5 km/h**

Q10 EXTENDING

He divided by minutes, not hours: 45 ÷ 0.5.

✓ **90 km/h**

Mastery solutions are in the Lab. Grades 8 and 9 are won on method, so a bare answer won't tell you much. Photograph or write your Mastery working in **Forensic Marking** and get it marked mark by mark, with the full solution and the mistake behind every lost mark. Your first marked question is free.

lab.mathsforensics.com/written/?sheet=CF-NUM-SPEED

Mark your evidence

Level	Marks	My score	Secured? (every mark)
Securing	9		☐
Extending	11		☐
Mastery	14		☐

R · Reading
Misread or missed part of the question

M · Method
Didn't know how to do it

A · Accuracy
Knew how, slipped in the working

Write R, M or A next to every mark you lost. Mostly R or A? The fix is technique, not more practice of the topic.

CASE CLOSED: SPEED AND DISTANCE-TIME GRAPHS

In this case file you've learned to:

- Use speed = distance ÷ time in all three arrangements.
- Convert between hours and minutes, and between km/h and m/s.
- Read speed from the gradient of a distance-time graph.
- Find distance from the area under a speed-time graph, and acceleration from its gradient.
- Use density and pressure with the same formula triangle idea.

Because every case comes down to one principle: numbers don't lie.

YOUR NEXT ASSIGNMENT

Practise every GCSE topic in the Lab

New numbers every time, feedback that names the mistake behind each wrong answer, and handwritten working marked like an examiner. Start free.

https://www.mathsforensics.com/the-lab