Speed, distance and acceleration

Worked solutions

GCSE science calculations

This topic online

1 Ibrahim cycles to school at a constant speed of 6 m/s for 50 s.

Calculate the distance he travels. (2 marks)

Distance travelled = speed × time

$s = vt$

$s = 6 \times 50$

$s = 300$ m

2 A car joins a motorway. Its velocity increases from 4 m/s to 22 m/s in 6 s.

Calculate the acceleration of the car. (2 marks)

Acceleration = change in velocity ÷ time taken

$a = (22 - 4) \div 6$

$a = 18 \div 6$

$a = 3$ m/s^2

3 Grace walks along a straight path. Her distance-time graph is a straight line through these points:

Time in s	0	10	20	30
Distance in m	0	14	28	42

Use the gradient of the graph to calculate her speed. (2 marks)

Speed = gradient = change in distance ÷ change in time

$v = (42 - 0) \div (30 - 0)$

$v = 42 \div 30$

$v = 1.4$ m/s

4 An e-scooter travels at a constant speed of 18 km/h for 4 minutes.

Calculate the distance it travels in metres. (3 marks)

Distance travelled = speed × time

18 km/h = 18 000 m ÷ 3600 s = 5 m/s

4 minutes = 240 s

$s = 5 \times 240$

$s = 1200$ m

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5 A train leaves a station. It speeds up from rest to 72 km/h in 40 s.
Calculate the acceleration of the train. (3 marks)

Acceleration = change in velocity ÷ time taken

72 km/h = 72 000 m ÷ 3600 s = 20 m/s

$a = (20 - 0) \div 40$

$a = 0.5\ m/s^2$

6 A coach travels along the M5 at an average speed of 25 m/s for 2.5 hours.
Calculate the distance it travels. Give your answer in kilometres. (3 marks)

Distance travelled = speed x time

2.5 hours = 2.5 x 3600 = 9000 s

$s = 25 \times 9000$

$s = 225\ 000\ m$

225 000 m = 225 km

$s = 225\ km$

7 A lift in a shopping centre rises 24 m at a constant speed of 1.6 m/s.
Calculate the time the lift takes. (2 marks)

Distance travelled = speed x time

$24 = 1.6 \times t$

$t = 24 \div 1.6$

$t = 15\ s$

8 A cyclist is moving at 3 m/s. She accelerates at 1.5 m/s^2 for 8 s.
Calculate her final velocity. (3 marks)

Acceleration = change in velocity ÷ time taken

$1.5 = \Delta v \div 8$

$\Delta v = 1.5 \times 8$

$\Delta v = 12\ m/s$

final velocity = 3 + 12

15 m/s

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9 A car is travelling at 20 m/s. The driver brakes and the car decelerates at 5 m/s^2 until it stops.
Calculate the braking distance. (3 marks)

$v^2 - u^2 = 2as$

$v = 0$, $u = 20$ m/s, $a = -5$ m/s^2 (slowing down)

$0^2 - 20^2 = 2 \times (-5) \times s$

$-400 = -10s$

$s = -400 \div -10$

$s = 40$ m

10 A delivery van starts from rest. Its velocity-time graph is made of two straight lines:

Time in s	0	4	10
Velocity in m/s	0	8	8

From 0 s to 4 s the line slopes up from 0 m/s to 8 m/s. From 4 s to 10 s the line is flat at 8 m/s.

a. Use the gradient of the graph to calculate the acceleration of the van in the first 4 s.

b. Use the area under the graph to calculate the total distance the van travels in the 10 s. Show your working. (4 marks)

a)

Acceleration = gradient = change in velocity ÷ change in time

$a = (8 - 0) \div (4 - 0)$

$a = 2$ m/s^2

b)

Distance = area under the graph

triangle $= 0.5 \times 4 \times 8 = 16$ m

rectangle $= (10 - 4) \times 8 = 48$ m

total $= 16 + 48$

64 m

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11 **Higher tier**

A ball is dropped from rest from a height of 1.8 m. It accelerates downwards at 9.8 m/s^2. Ignore air resistance.

Calculate the speed of the ball just before it hits the ground. Give your answer to 2 significant figures. Show your working.

(3 marks)

$v^2 - u^2 = 2as$

$v^2 - 0^2 = 2 \times 9.8 \times 1.8$

$v^2 = 35.28$

$v = \sqrt{35.28}$

$v = 5.9397... \text{ m/s}$

$v = 5.9 \text{ m/s (2 s.f.)}$

12 A train is travelling at 108 km/h. It brakes with a constant deceleration and stops in a distance of 1200 m.

a. Calculate the deceleration of the train. Show your working.

b. Calculate the time the train takes to stop.

(5 marks)

a)

$108 \text{ km/h} = 108\,000 \text{ m} \div 3600 \text{ s} = 30 \text{ m/s}$

$v^2 - u^2 = 2as$

$0^2 - 30^2 = 2 \times a \times 1200$

$-900 = 2400a$

$a = -900 \div 2400$

$a = -0.375 \text{ m/s}^2$

deceleration = 0.375 m/s^2

b)

Acceleration = change in velocity ÷ time taken

$0.375 = 30 \div t$

$t = 30 \div 0.375$

$t = 80 \text{ s}$

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13 A bus of mass 12 000 kg pulls away from a bus stop. It speeds up from rest to 9.0 m/s in 15 s. In this time it travels 68 m.

Calculate the acceleration of the bus. (2 marks)

The 12 000 kg and the 68 m are not needed

Acceleration = change in velocity ÷ time taken

$\Delta v = 9.0 - 0 = 9.0$ m/s

$a = 9.0 \div 15$

0.6 m/s^2

14 Amir walks 1.2 km to the shop in 15 minutes. He spends 10 minutes in the shop, then takes 20 minutes to walk the same 1.2 km home.

Calculate Amir's average speed on the walk to the shop, in m/s. Give your answer to 2 significant figures. (3 marks)

Use only the walk to the shop: 1.2 km in 15 minutes

1 km = 1000 m

1.2 km $= 1.2 \times 1000 = 1200$ m

1 minute = 60 s

15 minutes $= 15 \times 60 = 900$ s

Distance travelled = speed x time

$1200 = v \times 900$

$v = 1200 \div 900$

$v = 1.333...$ m/s

Round to 2 significant figures

1.3 m/s

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