Speed

4.5.6.1.2 · Forces · revision notes

Speed is how fast something is moving, without direction. You need to use s = v t, calculate average speeds for journeys where the speed changes, and recall typical speeds for walking, running, cycling, transport and sound. Expect short calculations and estimates.

Key facts

- s = v t (distance travelled = speed × time)
- Average speed = total distance ÷ total time
- Speed of sound in air ~330 m/s
- km/h ÷ 3.6 = m/s
- Units: s in m, v in m/s, t in s
- Walking ~1.5 m/s, running ~3 m/s, cycling ~6 m/s
- Car ~13 m/s in a town, ~30 m/s on a motorway
- Speed is a scalar

Notes

What speed is

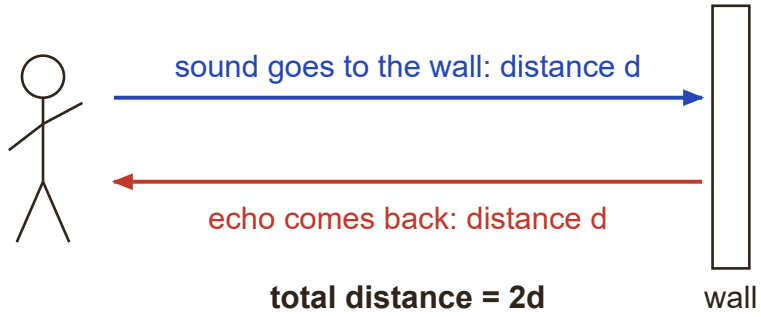
- Speed is the distance travelled per unit time. It does not involve direction, so it is a **scalar** quantity.
- The speed of a moving object is rarely constant. When people walk, run or travel in a car, their speed is constantly changing.
- The speed at which a person can walk, run or cycle depends on many factors, including their age, their fitness, the terrain and the distance travelled.

Calculating speed

- distance travelled = speed × time: **s = v t** (for an object moving at constant speed).
- s in metres (m), v in metres per second (m/s), t in seconds (s).
- When the speed changes during a journey, use **average speed = total distance ÷ total time**.
- To measure a speed, measure a distance (e.g. with a tape measure) and the time taken (e.g. with a stopwatch or light gates), then divide.

Typical speeds to recall

- Walking ~1.5 m/s; running ~3 m/s; cycling ~6 m/s.
- Car in a town ~13 m/s (30 mph); car on a motorway ~30 m/s (70 mph); fast train ~50 m/s; passenger jet ~250 m/s.
- Sound in air ~330 m/s. The speed of sound and the speed of the wind both vary.



For an echo, the sound travels there and back: use distance = 2 × the distance to the wall.

- The symbol ~ means 'approximately'.

Unit conversions

- km to m: × 1000. Minutes to seconds: × 60. Hours to seconds: × 3600.
- km/h to m/s: × 1000 ÷ 3600, which is the same as ÷ 3.6. So 72 km/h = 20 m/s.

How to answer each type of question

Calculate with s = v t

2 to 3 marks | Grade 4

1. Convert the time to seconds (and the distance to metres).
2. Write s = v t, or its rearranged form, and substitute.
3. Give the answer with a unit.

Example. A cyclist rides at a constant speed of 6.0 m/s for 8.0 minutes.
Calculate the distance travelled.

Model answer.

t = 8.0 × 60 = 480 s (1)
s = 6.0 × 480 (1)
s = 2880 m (1)

Calculate an average speed

3 marks | Grade 5

1. Add up the total distance.
2. Add up the total time, including any stops that are part of the journey.
3. Divide, and convert to the units asked for.

Example. A bus travels 3.6 km in 6.0 minutes, stops for 2.0 minutes, then travels 2.4 km in 4.0 minutes.
Calculate the average speed of the bus for the whole journey, in m/s.

Model answer.

total distance = 3.6 + 2.4 = 6.0 km = 6000 m (1)
total time = 6.0 + 2.0 + 4.0 = 12.0 min = 720 s (1)
average speed = 6000 ÷ 720 = 8.3 m/s (1)

Calculate with the speed of sound (echoes)

2 marks | Grade 6

1. For an echo, the sound travels to the surface and back, so double the distance.
2. Use t = s ÷ v.

Example. A person stands 165 m from a large wall and claps once.
speed of sound in air = 330 m/s
Calculate the time between the clap and hearing the echo.

Model answer.

distance travelled by the sound = 2 × 165 = 330 m (1)
t = 330 ÷ 330 = 1.0 s (1)

Estimate using typical speeds

2 to 3 marks | Grade 7

1. State the typical speed you are using.
2. Convert units and use s = v t.
3. Round the answer sensibly and give it in the units asked for.

Example. Estimate how long it takes a student to walk 2 km to school. Give your answer in minutes.

Model answer.

typical walking speed ~1.5 m/s (1)
t = 2000 ÷ 1.5 ≈ 1300 s (1)
≈ 22 minutes (1)

Don’t lose marks

- Not converting minutes or hours into seconds.

- Averaging the speeds of the parts of a journey instead of dividing the total distance by the total time.
- Leaving out the time spent stopped when the question asks for the average speed of the whole journey.
- Forgetting to double the distance in echo questions.

More tips

Memory tricks

- Formula triangle: s on top, v and t underneath.
- m/s to km/h: × 3.6. km/h to m/s: ÷ 3.6.
- Sense check with typical speeds: a car at 300 m/s means something has gone wrong.
- Echo questions: the sound goes there and back, so double the distance.

Exam technique

- s = v t is on the Physics Equations Sheet: pick it, rearrange it and use it. Here s stands for distance, not speed.
- In estimates, state the typical value you used; any sensible value earns the mark.
- Check the units the question asks for (m/s, km/h, minutes) before giving your final answer.

What each grade needs

What you need to be able to do, from the first marks up to the top grade.

Grade 3 — **State that speed is a scalar**
Speed is the distance travelled per unit time and has no direction.

Grade 4 — **Calculate distance using s = v t**
For example, 1.5 m/s for 60 s gives 90 m.

Grade 4 — **Recall typical speeds of everyday motion**
Walking ~1.5 m/s, running ~3 m/s, cycling ~6 m/s, sound in air ~330 m/s.

Grade 5 — **Find speed or time using s = vt**
v = s ÷ t and t = s ÷ v.

Grade 5 — **Calculate average speed for a whole journey**
Average speed = total distance ÷ total time.

Grade 6 — **Convert units of distance, time and speed**
km to m × 1000, minutes to seconds × 60, km/h to m/s ÷ 3.6.

Grade 7 — **Estimate speeds, distances and times**
For example, walking 1 km at ~1.5 m/s takes about 670 s, roughly 11 minutes.

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