

Stopping distance

4.5.6.3.1 · Forces · revision notes

The stopping distance of a vehicle is the thinking distance plus the braking distance. You need to know what affects each part, how speed affects stopping distance, and how to calculate stopping distances from data. If you take GCSE Physics (not Combined Science), you also need to interpret graphs of stopping distance against speed for different vehicles.

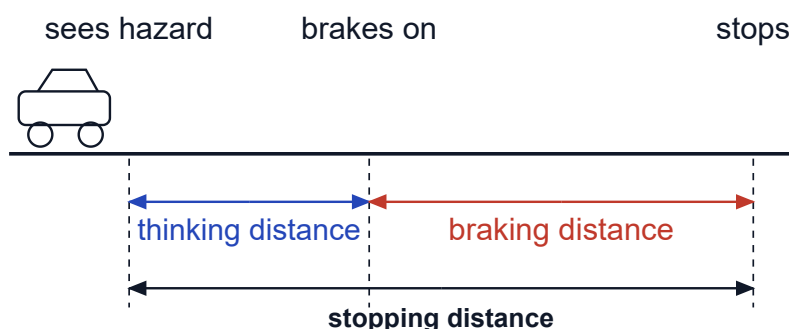
Key facts

- Stopping distance = thinking distance + braking distance
- Thinking distance = speed $\times$ reaction time
- Thinking distance $\propto$ speed (same reaction time)
- Greater speed $\rightarrow$ greater stopping distance
- Thinking distance: affected by reaction time.
- Braking distance: affected by road, weather, brakes, tyres, mass

Notes

Two parts

- Stopping distance = thinking distance + braking distance.**
- Thinking distance:** the distance the vehicle travels during the driver's reaction time, between seeing a hazard and applying the brakes.
- Braking distance:** the distance the vehicle travels under the braking force, from applying the brakes until it stops.



Stopping distance = thinking distance + braking distance.

The effect of speed

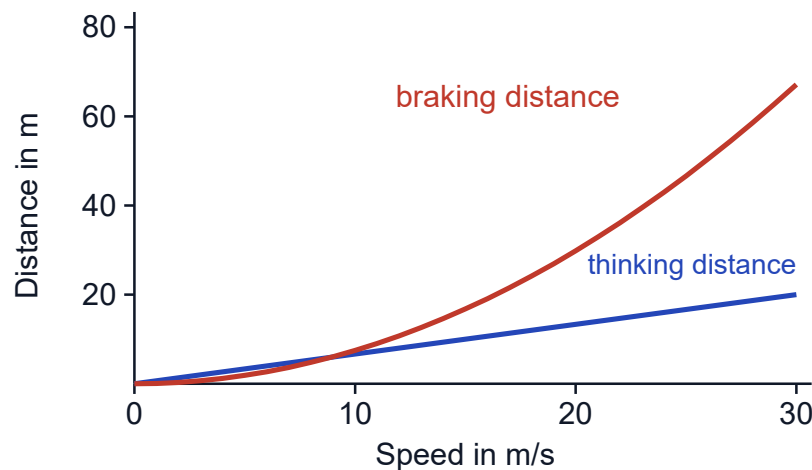
- For a given braking force, the greater the speed of the vehicle, the greater the stopping distance.
- Thinking distance = speed $\times$ reaction time. For the same reaction time, thinking distance is directly proportional to speed: double the speed, double the thinking distance.
- So at higher speeds, the braking distance makes up a bigger share of the stopping distance.

What affects each part

- Thinking distance depends on the speed and on the driver's reaction time, which is increased by tiredness, drugs, alcohol and distractions.
- Braking distance depends on the speed, the road and weather conditions (wet or icy), the condition of the brakes and tyres, and the mass of the vehicle.

Graphs of stopping distance against speed

- A graph of thinking distance against speed is a straight line through the origin (for a constant reaction time).
- A graph of braking distance against speed is a curve that gets steeper, because braking distance increases faster than speed.



Thinking distance $\propto$ speed (straight line); braking distance rises much faster (curve).

- Graphs for different vehicles can be compared by reading each line at the same speed. For example, a heavily loaded lorry usually has a greater stopping distance than a car at the same speed, so it needs a bigger gap to the vehicle in front.

How to answer each type of question

Calculate a stopping distance

3 marks

Grade 5

- Thinking distance = speed $\times$ reaction time.
- Add the braking distance.
- Give the answer in m.

Example. A driver is travelling at 15 m/s. Her reaction time is 0.60 s. The braking distance of her car is 17 m.

Calculate the stopping distance.

Model answer. thinking distance = 15×0.60 (1) = 9.0 m (1)

stopping distance = $9.0 + 17 = 26$ m (1)

Don't lose marks

- ✗ Saying alcohol or tiredness increases the braking distance. They increase the reaction time, and so the thinking distance.
- ✗ Saying wet roads increase the thinking distance. Road conditions affect the braking distance.
- ✗ Assuming that stopping distance is directly proportional to speed.
- ✗ Forgetting to add the thinking distance when the question asks for the stopping distance.

More tips

Memory tricks

- Stop = Think + Brake.
- Double the speed: thinking distance $\times 2$, braking distance $\times 4$.
- Thinking distance depends on the driver; braking distance depends on the vehicle and the road.

Exam technique

- Always say which part of the stopping distance a factor affects: thinking or braking.
- If you are given a speed and a reaction time, calculate the thinking distance with $s = v t$.
- When evaluating data or a graph, quote numbers from it to support your answer.

What each grade needs

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

Grade 3

Define stopping distance as thinking plus braking

Thinking distance is covered during the reaction time; braking distance is covered while the brakes act.

Grade 4

Calculate stopping distance from given data

Add the thinking distance and the braking distance.

Grade 5

Calculate thinking distance using $s = v t$

Thinking distance = speed $\times$ reaction time.

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