Reaction time

4.5.6.3.2 · Forces · revision notes

Reaction time is the time between a driver seeing a hazard and acting on it. You need to recall typical values (0.2 s to 0.9 s), the factors that increase reaction time, how reaction time affects thinking distance, and how to measure and evaluate reaction times, for example with a falling ruler.

Key facts

- Typical reaction time: 0.2 s to 0.9 s
- Thinking distance = speed × reaction time
- Ruler drop: the longer the distance fallen, the longer the reaction time
- Reaction time is increased by tiredness, drugs, alcohol and distractions
- Longer reaction time → longer thinking distance → longer stopping distance
- Grade 8+ only Ruler drop calculation: $v^2 = 2 a s$ with $a = 9.8$ m/s^2, then $t = v \div a$

Notes

Reaction time

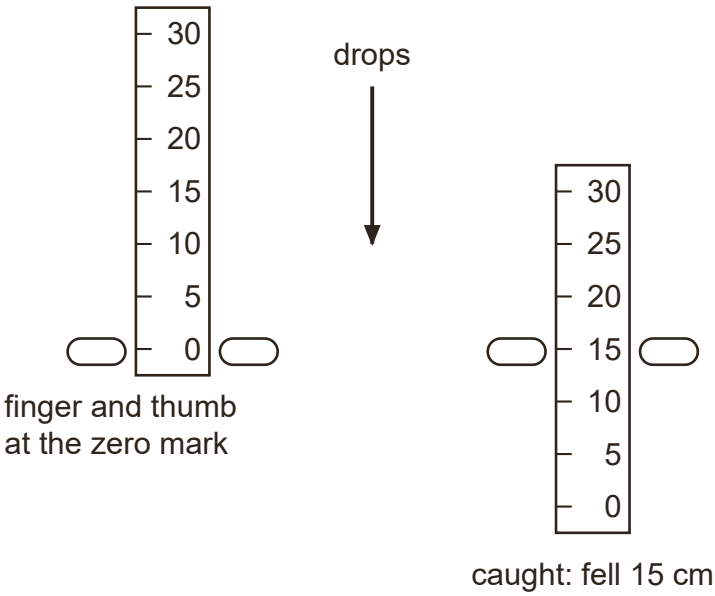
- Reaction time is the time between seeing a hazard (or other stimulus) and responding to it, e.g. pressing the brake pedal.
- Reaction times vary from person to person. Typical values range from **0.2 s to 0.9 s**.
- A driver's reaction time can be increased by **tiredness**, **drugs** and **alcohol**.
- **Distractions**, such as using a mobile phone or talking to passengers, may also affect a driver's ability to react.

Reaction time and thinking distance

- During the reaction time, the vehicle keeps moving at its original speed.
- Thinking distance = speed × reaction time ($s = v\ t$).
- A longer reaction time or a greater speed gives a longer thinking distance, and so a longer stopping distance.
- Example: at 25 m/s, an increase in reaction time from 0.5 s to 0.9 s increases the thinking distance from 12.5 m to 22.5 m.

Measuring reaction time: the ruler drop

- A partner holds a metre ruler vertically, with the zero mark level with the top of your open finger and thumb.
- They drop it without warning. You catch it as quickly as you can and read the distance it fell.



The ruler-drop test: the further it falls before you catch it, the longer your reaction time.

- The further the ruler falls, the longer your reaction time. A conversion table or graph turns the distance into a time.
- You can also calculate the time: the ruler falls from rest with an acceleration of 9.8 m/s^2, so use $v^2 = 2 \times 9.8 \times$ distance, then $t = v \div 9.8$. Grade 8+ only
- Repeat several times and calculate a mean. Keep the same catching hand, the same starting position and the same person dropping the ruler.
- To test a distraction (e.g. listening to music), do the repeats with and without it, keeping everything else the same, and compare the two means.
- Computer tests, where you click as soon as the screen changes, are another method.

How to answer each type of question

Recall typical values and factors 3 marks Grade 3

1. Give a value between 0.2 s and 0.9 s.
2. Choose from tiredness, alcohol, drugs, distractions.

Example. (a) Give a typical value for a person's reaction time.
(b) Give **two** factors that could increase a driver's reaction time.

Model answer.

(a) any value from 0.2 s to 0.9 s (1)
(b) any two from: tiredness / drinking alcohol / taking drugs / distractions such as using a phone (2)

Calculate a change in thinking distance

3 marks | Grade 5

1. Calculate the thinking distance for each reaction time with s = v t.
2. Subtract to find the change.

Example. A driver's reaction time is normally 0.50 s. While using a phone, it is 0.80 s. Calculate the increase in thinking distance at a speed of 20 m/s.

Model answer.

normal: 20 × 0.50 = 10 m (1)

using a phone: 20 × 0.80 = 16 m (1)

increase = 6.0 m (1)

Describe how to measure reaction time

4 marks | Grade 5

1. Describe the starting position of the ruler and hand.
2. Say that the ruler is dropped without warning and caught.
3. Say what is read and how it becomes a time.
4. Say how the result is made more reliable.

Example. Describe how a student can use a metre ruler to measure a partner's reaction time.

Model answer.

The partner holds their finger and thumb open, level with the zero mark of the ruler held vertically above (1).

The student drops the ruler without warning (1).

The partner catches it and the distance fallen is read from the ruler (1).

A conversion table (or graph) gives the reaction time; repeat several times and find the mean (1).

Evaluate reaction time data

3 marks | Grade 4

1. Identify any result that does not fit the pattern (anomaly).
2. Leave it out and calculate the mean of the rest.
3. Round to a sensible number of significant figures.

Example. The table shows a student's reaction times from four ruler-drop tests.

Test	Reaction time in s
1	0.21
2	0.24
3	0.46
4	0.22

(a) Identify the anomalous result.
(b) Calculate the mean reaction time, ignoring the anomalous result.

Model answer.

(a) 0.46 s (1)

(b) (0.21 + 0.24 + 0.22) ÷ 3 = 0.67 ÷ 3 (1)

= 0.22 s (1)

Calculate a reaction time from a ruler-drop distance

3 marks | Grade 8

1. The ruler starts from rest, so u = 0 and a = 9.8 m/s^2.
2. Use $v^2 - u^2 = 2\,a\,s$ to find v.
3. Use $a = \Delta v \div t$, so $t = v \div a$.

Example. In a ruler-drop test, the ruler falls 0.18 m before it is caught.
Use the equation $v^2 - u^2 = 2\,a\,s$, with a = 9.8 m/s^2, to calculate the reaction time.

Model answer.

$v^2 = 0 + 2 \times 9.8 \times 0.18 = 3.528$ (1)

v = 1.88 m/s (1)

t = 1.88 ÷ 9.8 = 0.19 s (1)

Don’t lose marks

- Saying alcohol increases the braking distance. It increases the reaction time, and so the thinking distance.
- Giving a reaction time of several seconds. Typical values are less than 1 s.
- Including an anomalous result when calculating a mean.

- In the ruler drop, letting the catcher see when the ruler is about to be dropped, or changing the starting position of the fingers.

More tips

Memory tricks

- Things that slow reactions: tiredness, drugs, alcohol, distractions.
- Quick thinking distance: speed in m/s × reaction time in s. At 30 m/s with 0.7 s, it is 21 m.
- Reaction time affects the thinking distance only, never the braking distance.

Exam technique

- For method questions, say what is measured (the distance fallen), how it becomes a reaction time, and how you make the result more reliable (repeats and a mean).
- In 'evaluate' questions, quote numbers from the data and compare like with like, e.g. at the same speed.
- Link each factor in a chain: reaction time → thinking distance → stopping distance.

What each grade needs

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

Grade 3 — **Recall typical reaction times**
Typical reaction times range from 0.2 s to 0.9 s.

Grade 4 — **List factors that increase reaction time**
Tiredness, drugs, alcohol and distractions (e.g. using a phone).

Grade 4 — **Evaluate reaction time measurements**
Identify anomalies, calculate means and suggest how to make a test fairer.

Grade 5 — **Calculate thinking distance from reaction time**
Thinking distance = speed × reaction time.

Grade 5 — **Describe the ruler-drop reaction time test**
Catch a dropped ruler; the further it falls before you catch it, the longer your reaction time.

Grade 5 — **Evaluate factors affecting thinking distance from data**
Compare thinking distances with and without a factor, at the same speed.

Grade 8 — **Calculate a reaction time from ruler-drop distance**
Use $v^2 - u^2 = 2\,a\,s$ with $a = 9.8$ m/s^2 to find v, then $t = v \div a$.

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