Reaction time

Answers, marking points and revision notes | AQA Combined Science 8464 and AQA GCSE Biology 8461

GCSE science required practicals

This practical online

Answers

1 In Kwame's investigation:

a. What is the independent variable?

b. What did Kwame actually measure in order to find the dependent variable? (2 marks)

a) Whether Lucy had drunk the cola or not (before and after the caffeine).

b) The distance in cm that the ruler fell before Lucy caught it.

Marking points

- Independent: caffeine / before or after the drink
- Measured: distance the ruler fell before being caught

2 Kwame used Lucy's dominant hand for every trial. Give one other control variable and explain why it matters. (2 marks)

Kwame should hold the ruler with the 0 cm mark level with the top of Lucy's thumb every time. If the start position changed, the distance read off would change even if her reaction time did not.

Marking points

- A sensible control, such as the start position of the ruler, the same person dropping it, or the same gap between thumb and finger
- A matching reason, such as otherwise the distance read would change for another reason

3 Explain why Kwame should wait a different length of time before each drop. (2 marks)

If he dropped it after the same wait each time, Lucy could guess when it was coming and move early. A random wait means she has to react to seeing the ruler fall, so the test measures her real reaction time.

Marking points

- So Lucy cannot predict or anticipate the drop
- So the result measures her true response to the stimulus

4 Give one reason why some people should not take part in this investigation, and say what Kwame should do about it. (2 marks)

Caffeine can raise the heart rate, which is risky for someone with a heart condition or who is sensitive to caffeine. Kwame should ask volunteers first and only test people who are allowed caffeine.

Marking points

- Caffeine can cause harm, such as raised heart rate, for some people
- Check health or consent first and exclude anyone at risk (or use a decaffeinated drink)

Free for classroom and home use: print, photocopy and share. Not for resale or re-hosting.

5 Identify the anomalous result. Suggest a reason for it. (2 marks)

Trial 5 before the drink, 31 cm, is anomalous because the others were 17 to 19 cm. Lucy was laughing, so she was distracted and slow to react.

Marking points

- 31 cm (trial 5 before the drink)
- Lucy was distracted (laughing), so she reacted late

6 Calculate the mean distance caught before the drink. Do not include the anomalous result. (2 marks)

(18 + 17 + 19 + 18) / 4 = 72 / 4 = 18 cm

Leave out 31

18 + 17 + 19 + 18 = 72

72 / 4 = 18

Mean = 18 cm

Marking points

- Adds the four valid results and divides by 4
- 18 cm

7 Calculate the mean distance caught after the drink. (2 marks)

(13 + 11 + 12 + 14 + 10) / 5 = 60 / 5 = 12 cm

13 + 11 + 12 + 14 + 10 = 60

60 / 5 = 12

Mean = 12 cm

Marking points

- Adds all five results and divides by 5
- 12 cm

Free for classroom and home use: print, photocopy and share. Not for resale or re-hosting.

8 Kwame used this conversion table:

10 cm = 0.14 s
12 cm = 0.16 s
14 cm = 0.17 s
16 cm = 0.18 s
18 cm = 0.19 s
20 cm = 0.20 s
22 cm = 0.21 s

Use the table and your means to find Lucy's reaction time before and after the drink. Then calculate the decrease in her reaction time. Show your working.

(3 marks)

Before: 18 cm = 0.19 s. After: 12 cm = 0.16 s.

Decrease = 0.19 - 0.16 = 0.03 s

Mean before = 18 cm, so reaction time = 0.19 s

Mean after = 12 cm, so reaction time = 0.16 s

Decrease = 0.19 - 0.16

Decrease = 0.03 s

Marking points

- Before: 0.19 s
- After: 0.16 s
- Decrease = 0.03 s

9 Calculate the percentage decrease in Lucy's reaction time after the drink.

Give your answer to 2 significant figures. Show your working.

(3 marks)

Decrease = 0.19 - 0.16 = 0.03 s

Percentage decrease = 0.03 / 0.19 x 100 = 16%

Decrease = 0.19 - 0.16 = 0.03 s

Percentage decrease = (0.03 / 0.19) x 100

= 15.79...

= 16% (2 significant figures)

Marking points

- Uses the decrease of 0.03 s
- Divides by the original 0.19 s and multiplies by 100
- 16% (2 significant figures)

10 **Higher tier**

Use the conversion table to explain why the distance caught is not directly proportional to reaction time.

(2 marks)

Doubling the distance from 10 cm to 20 cm only raises the time from 0.14 s to 0.20 s, not to 0.28 s. This is because the ruler accelerates as it falls, so it covers more distance in each extra hundredth of a second.

Marking points

- Uses data: doubling distance does not double time (for example 10 cm = 0.14 s but 20 cm = 0.20 s)
- Because the ruler speeds up (accelerates) as it falls

Free for classroom and home use: print, photocopy and share. Not for resale or re-hosting.

11 Kwame concluded that caffeine made Lucy's reaction time shorter. Give two reasons why this conclusion may not be valid, and suggest how to improve the investigation. (3 marks)

Lucy had practised five times before drinking, so she may simply have got better with practice. Also only one person was tested, so the result may not apply to other people. Kwame should test a large group, giving half of them a decaffeinated drink that looks the same, and compare the two groups.

Marking points

- The improvement could be due to practice (or tiredness or other factors), not caffeine
- Only one person tested, so the sample is too small to generalise
- Improvement: use a control group with a decaffeinated drink (and test many people)

12 The ruler has markings every 1 cm. Explain how a ruler with millimetre markings would improve the results. (2 marks)

It has a higher resolution, so each catch can be read more precisely, to the nearest 0.1 cm. This would show smaller differences between trials that 1 cm markings hide.

Marking points

- Higher resolution / readings taken to a smaller scale division
- So results are more precise and small differences can be seen

13 Explain why a reaction time is longer than the time for a reflex, such as pulling your hand away from a hot plate. (2 marks)

Catching the ruler is a conscious action, so the nerve impulse has to travel to the brain, be processed, and then be sent to the arm muscles. A reflex skips the conscious part of the brain and uses a shorter pathway through a relay neurone, so it is faster.

Marking points

- Reaction involves the brain making a conscious decision (longer pathway)
- Reflex is automatic and uses a shorter pathway through a relay neurone

Free for classroom and home use: print, photocopy and share. Not for resale or re-hosting.

14 Plan an investigation to find out whether people's reaction times are shorter with their dominant hand than with their non-dominant hand, using the ruler-drop test. (6 marks)

Choose a group of at least ten volunteers. Each person sits with their forearm resting on a table and their hand over the edge. Hold a 30 cm ruler vertically with the 0 cm mark level with the top of their thumb and a 2 cm gap between thumb and finger. Drop the ruler without warning, after a different wait each time, and record the distance in cm at the top of the thumb where it is caught. Do this five times with the dominant hand and five times with the non-dominant hand. Half the group should start with the dominant hand and half with the other, so practice does not favour one hand. The same person should drop the ruler every time, in the same quiet room, and no one should have had caffeine beforehand. Calculate the mean distance for each hand for each person, leaving out anomalies, and convert to reaction time with a conversion table. Compare the group mean for each hand to see if the dominant hand is faster.

Marking points (any 6, with the method in a logical order)

- Tests a group of people, not just one
- Ruler held vertically with zero at the top of the thumb
- Drop without warning, with varied waits
- Records distance where caught and converts it to time with a table
- Repeats several times for each hand
- Swaps the order of the hands for half the group (or allows practice first) to cancel out practice
- Controls: same dropper, same start gap, no caffeine, same conditions
- Calculates means, leaving out anomalies
- Compares the mean reaction time for each hand

How it is marked

- 5-6 marks: a clear, ordered plan that tests both hands in a group of people, uses repeats and means, controls the drop and the start position, deals with practice and converts distance to time.
- 3-4 marks: describes the ruler drop for both hands with some repeats or controls, but misses points such as testing a group or dealing with practice.
- 1-2 marks: a few relevant ideas, such as dropping a ruler and catching it with each hand, with little detail or control.

Revision notes: the method

Aim: To find out whether drinking a caffeinated drink changes a person's reaction time, measured with the ruler-drop test.

Equipment

- 30 cm ruler (or metre ruler) with clear cm markings
- Chair and table so the forearm can rest on the edge
- Conversion table from distance caught to reaction time
- Caffeinated drink, such as cola (only for people allowed caffeine)
- Measuring cylinder to give the same volume of drink
- Stopwatch or timer to time the wait after drinking
- Results table and pen

Method

1. The person being tested sits with their forearm resting on the table and their hand over the edge.

Free for classroom and home use: print, photocopy and share. Not for resale or re-hosting.

2. Hold a 30 cm ruler vertically so that the 0 cm mark is level with the top of their thumb, with the thumb and finger about 2 cm apart.
3. Without warning, drop the ruler. The person catches it as quickly as they can.
4. Read the distance in cm at the top of their thumb.
5. Repeat four more times, varying the wait before each drop so the person cannot predict it.
6. Give the person a set volume of cola and wait 10 minutes.
7. Repeat the five ruler drops with the same hand and the same person dropping the ruler.
8. Calculate the mean distance before and after, leaving out any anomalous results.
9. Use the conversion table to turn each mean distance into a reaction time.

Variables

- **Independent:** Whether the person has had a caffeinated drink (before or after the drink).
- **Dependent:** Reaction time, found from the distance the ruler falls before it is caught (read in cm and converted to seconds).
- **Control:** Same person being tested and same person dropping the ruler; Same hand (the dominant hand); Same starting position: 0 cm level with the top of the thumb; Same gap between thumb and finger; Same volume of drink and same waiting time after drinking

Hazards

Hazard	What could happen	How to reduce the risk
Caffeine	Can raise heart rate or cause a bad reaction in people with heart problems or caffeine sensitivity	Only test volunteers who are allowed caffeine, keep the dose small and offer a decaffeinated option
Falling ruler	Ruler could hit the eye or toes if dropped from too high	Drop from just above the hand and keep faces away from the ruler

Key points

- The further the ruler falls before it is caught, the longer the reaction time.
- Distance and time are not directly proportional, because the ruler speeds up as it falls, so always use the conversion table.
- Vary the time before each drop so the person reacts to the ruler, not to a rhythm.
- Caffeine is a stimulant: it speeds up nerve impulses, so reaction time should fall.
- Practice can also shorten reaction time, so a fair comparison needs a control (for example a decaffeinated drink).
- Reaction time involves a nervous pathway from eye to brain to arm muscles, so it is longer than a reflex.

Free for classroom and home use: print, photocopy and share. Not for resale or re-hosting.