Reaction Times
Lesson 1: Discover Phase

Australian Curriculum: Mathematics (Year 5)

ACMNA104: Recognise that the place value system can be extended beyond hundredths.

ACMNA105: Compare, order and represent decimals.

Lesson abstract

Students consider contexts where reaction times are important. They learn about tests for reaction times, test themselves and plot the times on a number line. They compare reaction times with other students.

Mathematical purpose (for students)

Reaction times are brief and are recorded as a decimal or as milliseconds (thousandths of a second).

Mathematical purpose (for teachers)

Reaction times can be measured, recorded either as a decimal number of seconds (using decimal place value to hundredths or thousandths) or alternatively as a whole number of milliseconds. Even very small numbers can be shown on a number line.

At the end of the Discover phase, students will be able to:

- Recognise contexts where reaction time can be important.
- Understand that there are units of time which are fractions of a second.
- Measure a person's reaction time.
- Compare reaction times to determine good reaction times in this context.

Lesson Length 45 minutes

Vocabulary Encountered

- reflex, response
- reaction time
- seconds, milliseconds

Lesson Materials

- if online test is chosen, access to internet for one computer or tablet per 3 or 4 students)
  e.g. https://faculty.washington.edu/chudler/java/redgreen.html
- if ruler drop test is chosen, one ruler and one printed Ruler Drop Reaction Time chart per 3 to 4 students
- Evidence Triangle (optional, see *Mathematical Inquiry into Authentic Problems Teachers' Guide*)
- Number line (0 to 1) for class display

We value your feedback after these lessons via https://www.surveymonkey.com/r/CV2TXTT

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Choose Test Before Lesson Starts

Inquiry Question: Who has the best reaction time?

In this unit, students need to measure their reaction times. There are two choices: using an online test or using the Ruler Drop test (which requires a ruler and a conversion chart). The unit can proceed with either choice, or maybe both in some classes.

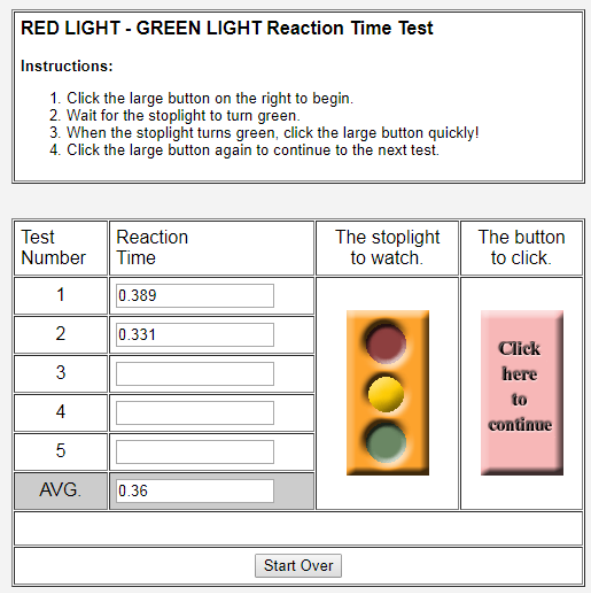
The online test requires very little set up but each group requires a computer or tablet. An advantage is that students with very slow reactions will still have their reaction time measured.

The Ruler Drop Test needs just one ruler per group, and a printed conversion chart. It is possible that a few students may not have a sufficiently quick reaction time to catch the ruler.

The Online Reaction Time Test by Jim Allen.

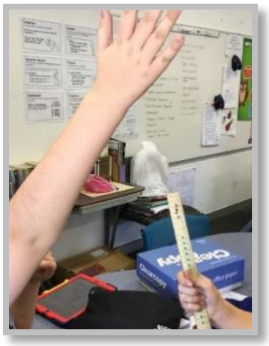
There are many online tests that are simple to use. This one, which does not have advertisements, is at https://faculty.washington.edu/chudler/java/redgreen.html.

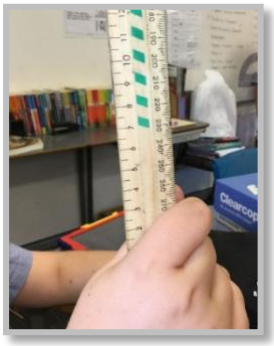
- The student clicks the pink button to start, and then waits to see the light go green before clicking the pink button again. That might happen anytime in the next 7 seconds.
- The reaction time in seconds is recorded to three decimal places.
- A running average is calculated for up to 5 tries.
- A reaction time of 0.2 seconds is very good and 0.3 seconds is somewhat slow.



The Ruler Drop Test

Another common reaction-time test is the ruler drop test. This involves catching a ruler dropped unexpectedly by another person, and converting the measurement on the ruler (distance dropped in cm) to a time measurement (reaction time in seconds) using a chart (Ruler Drop Reaction Time chart).





- One student holds the ruler up reasonably high. The zero mark on the ruler is at the bottom.
- The reacting student places finger and thumb *at the bottom of the ruler*, not touching but ready to grab.
  - In the image the reacting student's hand is too low.
- At an unpredictable time, the first student drops the ruler.
- The reacting student catches it between finger and thumb, and reads the distance below the thumb.
  - In the image, the student has not used finger and thumb, and seems to be reading the top half of the ruler, rather than the bottom.
- The number of seconds for the reaction time is determined by reading the chart.
- There are many online resources exploring this test (see References).
- Alternatively, a piece of card with reaction times printed on it can be used. Suggestions on how to make one can be found at http://www.topendsports.com/testing/reactionmake.htm.

Building Context

1. **Describe what reaction time is.** Students consider events in their own lives where reaction time is important. In swimming event or a running race, it is important to start as soon as possible, but not before the signal. In tennis, a player's reaction time can influence whether a player can return a shot well. A player's reaction time is critical when playing some computer games.
   You could show footage of the start of a 100m race so students can consider the importance of their reaction time to the starter's pistol https://www.youtube.com/watch?v=NHmEpqUFLZ8

2. **Introduce the** inquiry question '*Who has the best reaction time?*' **and discuss** what the term *best* might mean. The class will need to be clear that a *fast (short)* reaction time is nearly always best.

3. **Brainstorm** the kinds of people who probably have fast reaction times and provide reasons why. For instance, musicians, gamers and sports people in many different types of games. Students may wonder whether people of different ages have different reaction times, or people of different genders or of different heights. Record these ideas on the board.

Measuring Reaction Times

4. Ask students for ideas on how a reaction time might be measured. The idea is to measure just the time it takes to respond, and very little else.
5. Introduce your selected test – online test or Ruler Drop test. Demonstrate it carefully. Discuss as much of the physics (how the ruler drops under gravity and starts to fall faster and faster) and the biology (how messages go from the eye to the brain to the finger) as appropriate.
6. Allocate students to groups of 3 or 4, and set them to measure their own reaction times.
7. Take the opportunity to observe groups of students as they conduct their tests. Encourage students to consider fairness and accuracy. Some groups will struggle with interpreting the times or the Reaction Time Chart.

Evie	Nathan
13cm	25cm
11cm	18cm
15cm	18cm
8cm	27cm
15cm	21cm

Evie and Nathan used the Ruler Drop Test to measure their reaction times. They conducted the test five times each and recorded these results. They require teacher prompting to consider whether this kind of data can answer a question about *time*, and how it might do it. Encourage them to convert their data into times using the Ruler Drop Reaction Time chart.
If students can read the ruler to millimetres, discuss how to interpolate between the times given for centimetres.

Checkpoint

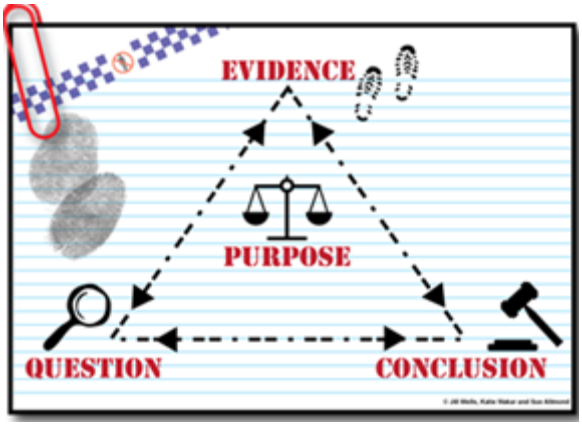
8. Explain the units and conventions used to record times. There are 1000 milliseconds in 1 second, just as there are 1000 millimetres in 1 metre. Note that 'centiseconds' or 'deciseconds' could be used, but they hardly ever are. "Milli" is always abbreviated to m, as in mm (millimetre), ml (millilitre) and ms (millisecond).

9. Different online tests may display time in different ways – discuss any that arise.
10. Link metric prefixes to decimal place value. Relate milliseconds to the place value of thousandths and to previously taught experiences involving fraction equivalence e.g. 10 tenths are equal to one whole, 10 hundredths are equal to one-tenth, 10 thousandths are equal to one-hundredth. Place value will be used to determine how to order and compare reaction times. Use previously taught models or materials to compare size e.g. linear arithmetic blocks, place value charts, area models or number lines.

Seconds	Seconds and Milliseconds
0.389 seconds	0s 389 ms
0.55 seconds	0s 550 ms

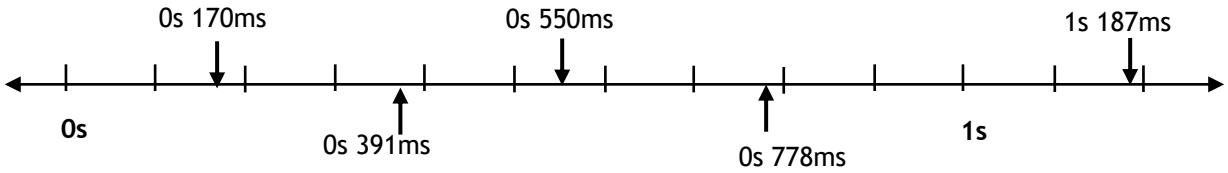
Finding a Typical Reaction Time

11. **Compare reaction times** by asking students to share some of their results. This may raise the issue of students not recording their reaction times previously. Relate the importance of recording data to the concept of evidence in the Evidence Triangle (below, see ST8 Teachers' Guide for images and explanation of its use). Discuss how they can use evidence to support a conclusion. It will be difficult to persuade an audience (classroom peers) that someone has the best reaction time without any evidence.



The Evidence Triangle

12. **Ask for suggestions and, if needed, model how to compare** reactions times. Construct a suitable number line on the board. Ask a few students for one of their own reaction times. You can place these values on a number line in two different ways:



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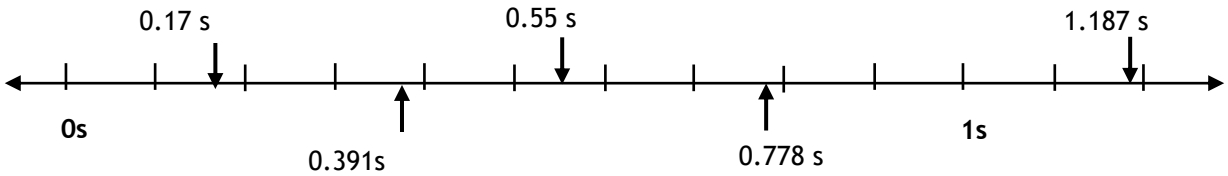

13. Provide students with more time to test and record their reaction times, and then to make a number line showing the reactions times of their group members. Assist with making and understanding the number line as required.

14. Ask students to reflect in their books on what they have learned about reaction times. For example:
    - Circle in colour your best reaction time. Write a statement which explains the reason why this is your best reaction time so far.
    - What is your best estimate of your own reaction time?
    - Do you think the test of reaction time that you used is a good one?
    - How does your reaction time compare with others in your group?

Conclusion

15. **Allow students to share their reflections and what they have learned about reaction times. Clarify any misconceptions.**

16. Now focus a discussion on the factors that may affect a person's reaction time. Refer to the list on the board from the beginning of the lesson (Step 3) regarding the kinds of people who might have the best reaction times and the factors that might influence this e.g. musicians practice every day, taller people might have longer fingers, or young children might have a faster reaction time than older students. **Ask students to predict** what kind of person would have the best reaction time, and explain their reasoning. These predictions will be used in the next lesson (Devise phase), so students need to record the prediction and their reason. An example might be *I think that athletes would have the best reaction times. If they can come first or second place in a race then they would probably have a fast reaction time to get a good start.*

References

https://www.helpingwithmath.com/printables/others/NumberLineGenerator01.htm

http://www.online-stopwatch.com/

https://faculty.washington.edu/chudler/java/redgreen.html

http://www.topendsports.com/testing/tests/reaction-stick.htm

http://www.topendsports.com/testing/reactionmake.htm

http://www.physicaleducationupdate.com/public/384.cfm

Ruler Drop Reaction Time			
Distance (cm)	Time (seconds)	Distance (cm)	Time (seconds)
1	0.045	16	0.181
2	0.064	17	0.186
3	0.078	18	0.192
4	0.09	19	0.197
5	0.101	20	0.202
6	0.111	21	0.207
7	0.12	22	0.212
8	0.128	23	0.217
9	0.136	24	0.221
10	0.143	25	0.226
11	0.15	26	0.23
12	0.156	27	0.235
13	0.163	28	0.239
14	0.169	29	0.243
15	0.175	30	0.247

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12	0.156	27	0.235
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