re(Solve) MATHS BY INQUIRY

Making Decisions with Data

Y5

Summary of learning goals

- It is important for students to learn how to collect, present and read data effectively, so that they might make reasoned judgements and decisions. This sequence of lessons takes students to a point where they can collect and analyse data to answer their own inquiry questions.

Australian Curriculum: Mathematics (Year 5)

ACMSP118: Pose questions and collect categorical or numerical data by observation or survey.

ACMSP119: Construct displays, including column graphs, dot plots and tables, appropriate for data type, with and without the use of digital technologies.

ACMSP120: Describe and interpret different datasets in context.

Summary of lessons

Who is this sequence for?

- Students undertaking this sequence will have mastered how to make and read simple column graphs, especially those with a category (e.g. colour) on the horizontal axis and a whole number one-to-one scale on the vertical axis. Some prior experience of reading scales that are not one-to-one is required (e.g. axis markers at 0, 100, 200, etc.). Students will use such scales during the lessons, so it is important that teachers select examples appropriate to the skills of their students.

Lesson 1: Unlabelled Graphs

Students construct their own stories to interpret information in unlabelled column graphs.

Lesson 2: How Thick is it?

Students conduct a short test of viscosity for four common household products. They time how long it takes for each product to flow down a slope for a specified distance, then represent the data on a column graph. Based on the data that they collect, students make statements about the viscosity of a selection of liquids.

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Reflection on this sequence

Rationale

We are constantly surrounded by data and statistics. The ultimate purpose of this sequence is to help students to use data effectively to make informed and intelligent statements based on evidence.

This sequence is organised so that students determine the required elements of a good graph through a structured and supported process, then collect and represent data from a class-based activity, and finally develop their own personal inquiry to answer a unique and individual question. In this way, the sequence itself builds knowledge and understanding of good data representation, so that students are empowered to support their own research with effective graphs.

reSolve mathematics is purposeful

- Students are provided with many opportunities throughout these lessons to participate in the process of making observations and drawing conclusions based on the information they collect.

reSolve tasks are inclusive and challenging

- Being open-ended, the first task allows students to choose a context that is meaningful to them.
- Prompts provide access and challenge.

reSolve classrooms have a knowledge-building culture

- Students will work collaboratively through the activities in these lessons as they collect and present data. They will be active in their engagement with tasks and have the opportunity to take risks as they explore issues.

Acknowledgements

The idea of unlabelled graphs is used in many references, including *Mathematics Assessment for Learning: Rich Tasks and Work Samples* (Australian Catholic University Research Services, 2013) by A. Downton, R. Knight, D. Clarke and G. Lewis.

LESSON 1

re(Solve) MATHS BY INQUIRY

Making Decisions with Data

Unlabelled Graphs

Y5

About this lesson

Students construct their own stories to interpret information in unlabelled column graphs.

Australian Curriculum: Mathematics (Year 5)

ACMSP120: Describe and interpret different datasets in context.

Mathematical purpose

- Students learn the need for graphs to be appropriately associated with titles, labelled axes, legends and keys, and numerical scales, in order to convey a message to readers.

Learning intention

- To make sense of the story told by a graph.

Time

A lesson of approximately 1 hour.

Resources

- Student Sheet 1 – The Unlabelled Graph
- Student Sheet 2 – Data Tells a Story

Vocabulary

- axis
- axis marker
- label
- scale

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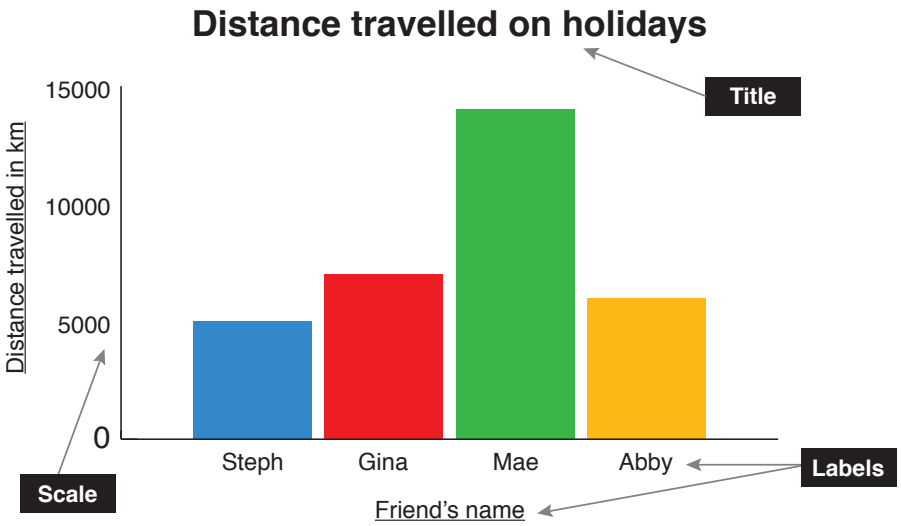
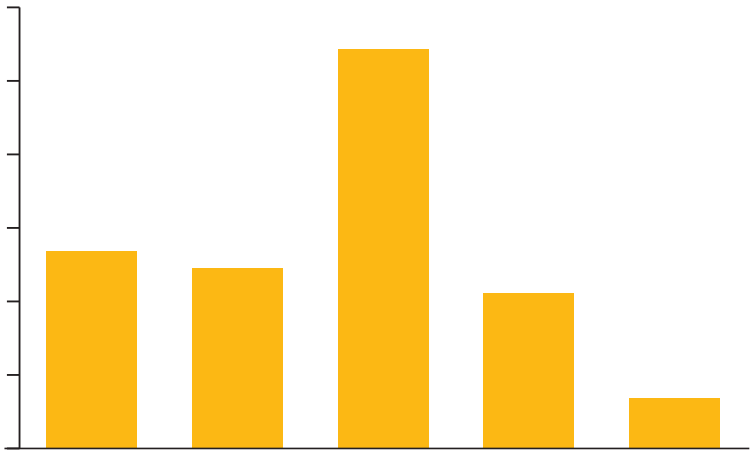
Teacher background information

A graph needs to have a title, labels, scale and possibly coding and/or colour to give it context.



Identifying the essential elements of a graph

Resources: Present students with Student Sheet 1 – The Unlabelled Graph.



Pose the question: *What might this graph be showing?*
What might be the story behind the data being represented?

Allow students time to explore the graph and to add missing elements to give the graph a context that they can explain and discuss with the class.

Noticing students' working

- Do students recognise the need for a scale?
  - ◊ Students will need to think carefully about scale on the vertical axis. If they choose each axis marker to be 1 unit, they will need to use fractions or decimals to describe the height of the columns, as none of them line up very neatly with the axis markers.
- Do students account for the variation in the data?
  - ◊ Variation is central to statistics. Encourage students to consider carefully why there is variation between the different columns.

Reflection

Select some students to present their graphs to the class.

Some questions for discussion:

- Was the choice of context appropriate for this type of data display?
- Was the graph labelled correctly for this context?
- What scale was used? Did it relate purposefully to the data?
- Does the explanation go beyond the superficial, to bring in deeper questions of analysis and interpretation?
- Were the mathematical statements simple comparisons (this one is bigger than that one) or were they more complex (predicting trends, analysing fictional populations, etc.)
- What are the essential elements of a column graph? What do we lose if some of these elements are left out?

Further activities

Activity 1

Resources: Give students Student Sheet 2 – Data Tells a Story.

The first graph has the horizontal axis labelled; the second has the vertical axis labelled.

Ask students to create stories for these graphs. What mathematical statements can we make with confidence about each of the datasets presented in these graphs?

Activity 2

Collect graphs from newspapers, magazines and the internet. Sort the graphs that you find into groups, such as:

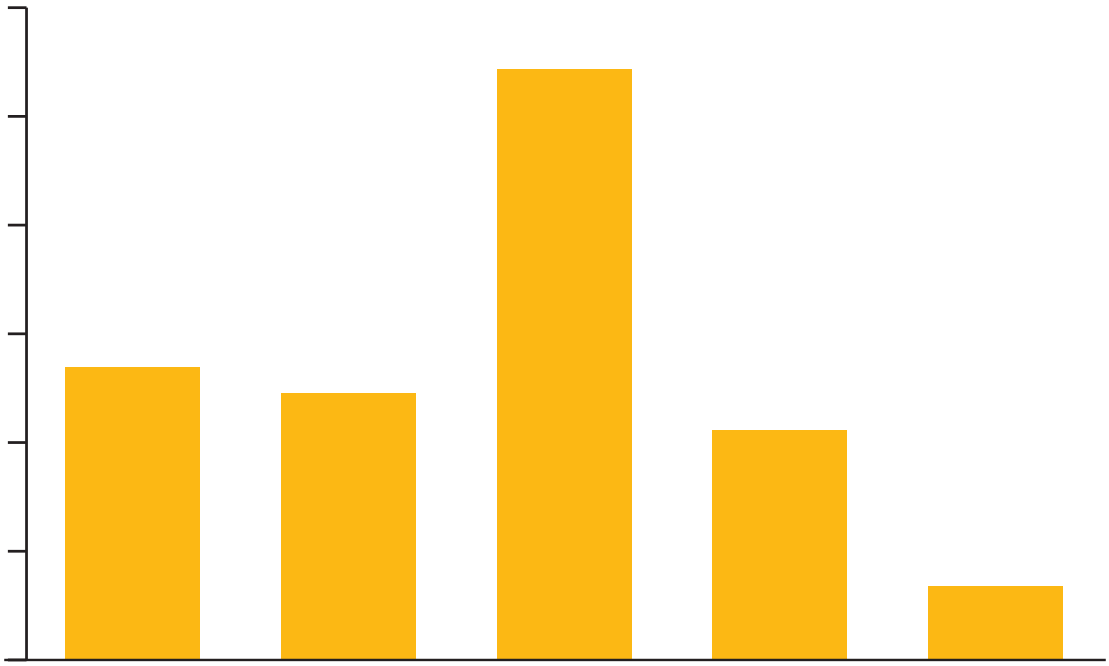
- Type of graphs – column graphs, line graphs, pie charts, picture graphs.
- Topic of graph – financial information, population data, opinion poll, etc.
- Purpose of graphs – to inform, to influence opinion, to sell a product.

Analyse the graphs that you find, looking for:

- clear headings and titles
- accurate scale
- missing elements
- misleading or confusing representation of data
- other elements of interest.

The Unlabelled Graph

Name: _____



1. What do you think this graph could be about? Make up a story that fits the graph.

2. Label the graph so that anyone looking at it will understand what it means.

3. Make four mathematical statements about the data in the graph.

   i.

   ii.

   iii.

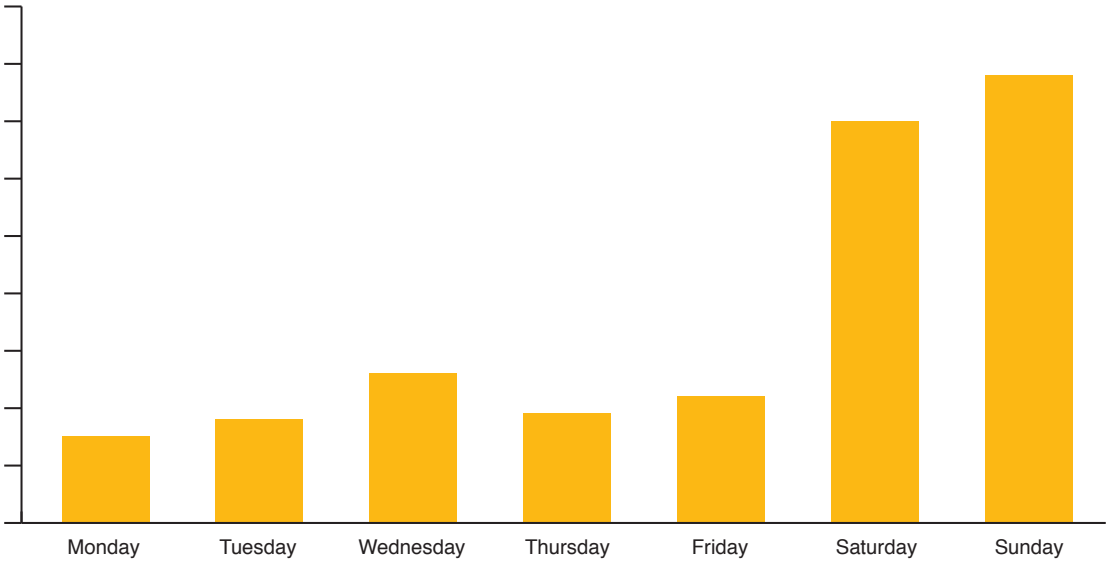
   iv.

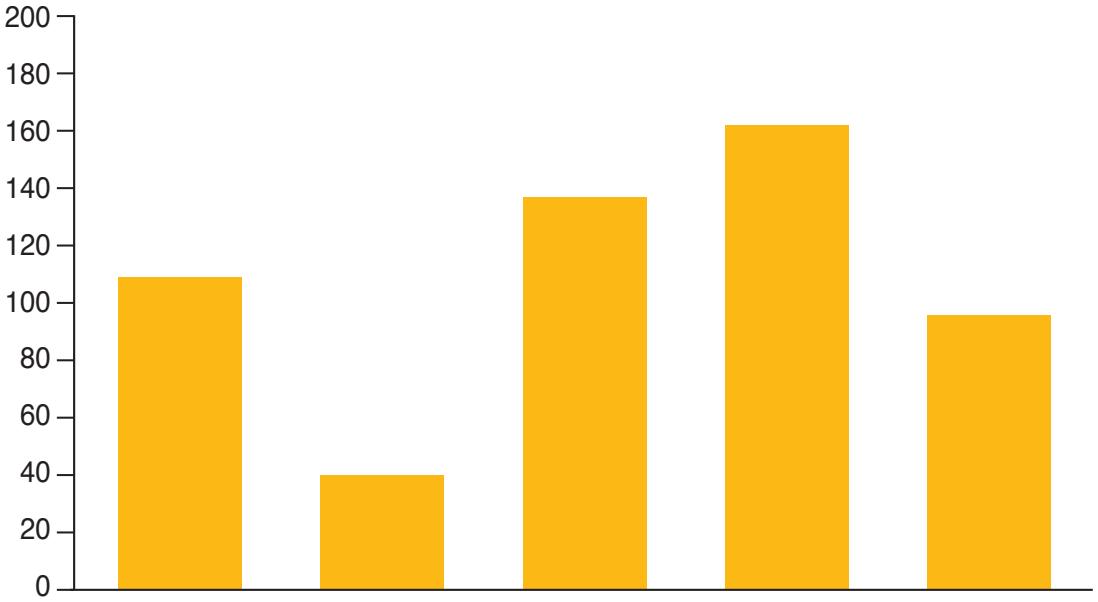
Data Tells a Story

Name: _____

Make up stories that fit these graphs.

Include some mathematical statements in your story, and remember to add titles, scale and labels if they are missing.





LESSON 2

Making Decisions with Data

How Thick is it?

Y5

About this lesson

Students conduct a short test of viscosity for four common household products. They time how long it takes for each product to flow down a slope for a specified distance, then represent the data on a column graph. Based on the data that they collect, students make statements about the viscosity of a selection of liquids.

Australian Curriculum: Mathematics (Year 5)

ACMSP118: Pose questions and collect categorical or numerical data by observation or survey.

ACMSP119: Construct displays, including column graphs, dot plots and tables, appropriate for data type, with and without the use of digital technologies.

ACMSP120: Describe and interpret different datasets in context.

Mathematical purpose

- Students draw a simple column graph to display the results of a scientific experiment. They also engage in a complex reasoning activity, and check the results using the collected data.

Learning intention

- To represent numerical data effectively on a column graph.

Time

A lesson of approximately 90 minutes

Vocabulary

- rate
- sample
- viscosity

Resources

- two clear plastic cups
- paper plates (at least one per pair of students)
- Student Sheet 1 – Recording Sheet
- stopwatch (ideally one per pair)
- 12 common household fluids of different viscosities (e.g. tomato sauce, honey, yoghurt, surface cleaning fluid, jam, shampoo, etc.)
- paper towel — for cleaning up
- sticky notes (several different colours)

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Teacher background information

This lesson makes a deliberate effort to link to the Australian Curriculum: Science topic for Year 5 that looks at the properties of solids, liquids and gases. Testing the viscosity of liquids is a common activity in this topic and there are digital resources available on Scootle, Primary Connections and other online locations. This lesson presents a variation on this experiment.

The mathematics focus of this lesson is to take the data from the experiment and to represent it effectively as a column graph.

Scootle resources:

- What the world is made of: properties of liquids - TLF-ID L3253
- Types of matter: solids, liquids and gases TLF-ID L5821

Clarifying viscosity

Resources: Show the students two clear cups, one containing water and the other containing honey.

Ask students if the water and honey are both liquids. How do they know? What are the properties of liquids that they can observe?

Discuss the idea of viscosity, using the cups of water and honey as examples.

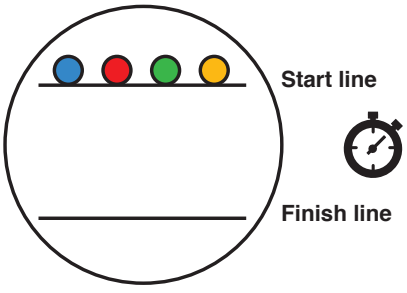
Experimenting with liquids

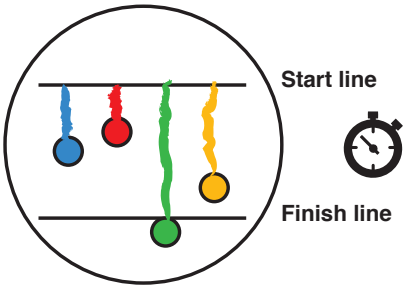
The viscosity test

Resources: Provide students with a paper plate, stopwatch and Student Sheet 1 – Recording Sheet.

Method:

1. Students record the names of all 12 liquids to be tested on their recording sheet and make predictions about the viscosities of the liquids. They rank the list in order of 1 to 12 (1 = fastest or least viscous; 12 = slowest or most viscous).
2. Students work in pairs and choose four liquids to test from the range of 12 liquids available. Ensure that the liquids are distributed randomly between student pairs and that all 12 are being tested.
3. Students draw parallel 'start' and 'finish' lines that are 10 cm apart on a paper plate.
4. Place a small drop of each liquid onto the paper plate, behind the start line.
5. Tilt the plate vertically.
6. Time how long it takes each liquid to get to the finish line.
7. Record the four time measurements on the recording sheet.

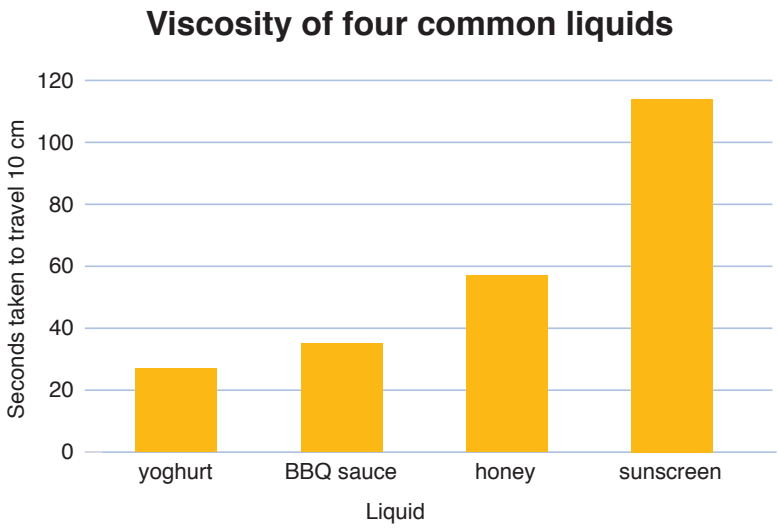




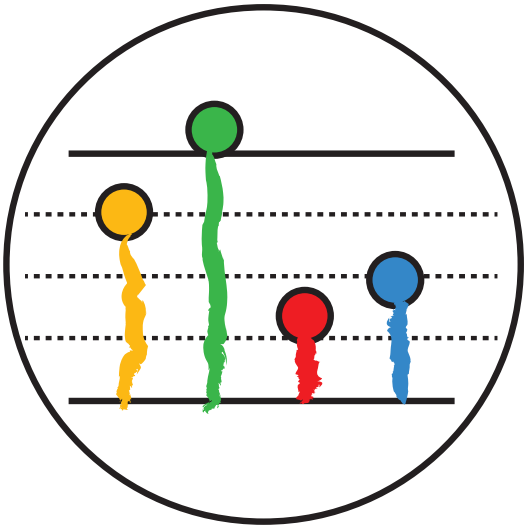
Graphing the data

Ask students to draw a column graph showing the time taken for each liquid to travel 10 cm.

Possible student response:



Next, ask students to place their plates flat on the table and turn them so that the starting line is at the bottom of the plate (as shown at right). Observe that the plate now resembles a column graph.



Ask students: *What is the difference between this 'column graph' and the column graph you have just drawn?*

Teacher notes:

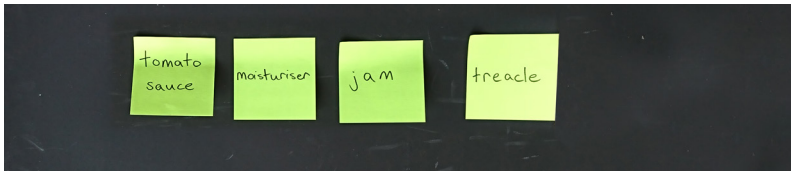
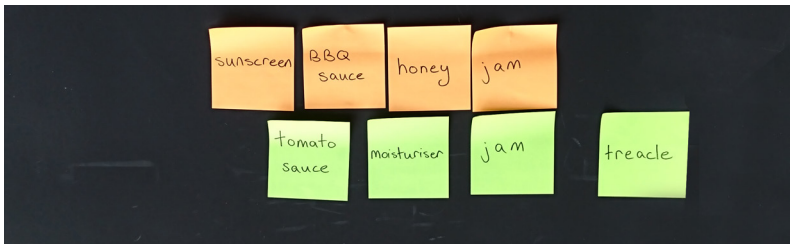
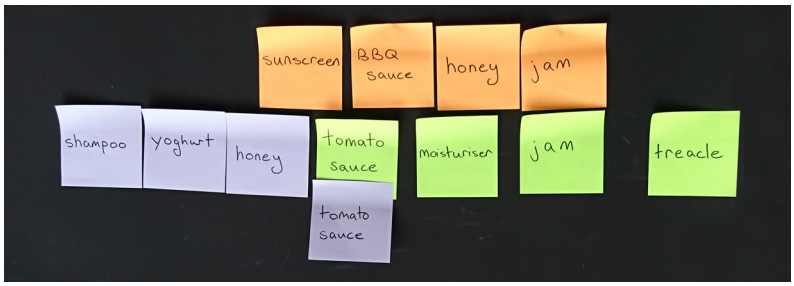
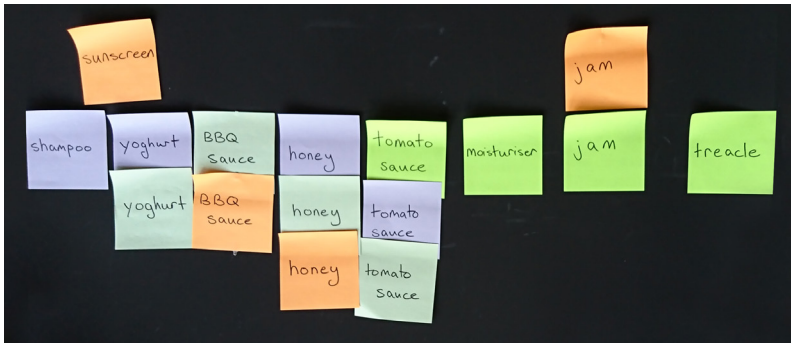
- The students' column graph shows the time taken for the liquid to travel a given distance (in this case, 10 cm). The 'column graph' on the plate shows the distance travelled by the liquid over a given time (however much time has passed since beginning the experiment).

Students may choose to measure the path of each liquid and draw a second column graph to represent the data more clearly.

Discuss: Is the plate 'column graph' the 'opposite' of the students' column graph; that is, is the liquid with the longest time also the liquid that travelled the shortest distance, and vice versa? Would you expect the graphs to be 'opposites'? Why or why not?

Organising the data

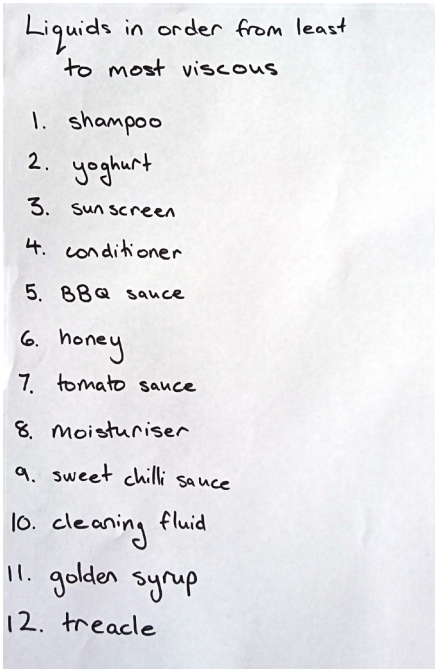
Ask students to rank their four liquids in order from least viscous (i.e. fastest) to most viscous (i.e. slowest). Have each group write the names of their liquids onto sticky notes along with a number to indicate the ranking (1 for least viscous, 4 for most viscous). Ask students to consult other groups to look at the ranking for liquids that they did not test. Using this information, arrange all 12 liquids in order from least to most viscous, as outlined below.

Group 1 puts their list of liquids in order.	 From left to right: tomato sauce, moisturiser, jam, treacle.
Group 2 adds its liquids. These students know where on the scale to place jam and they know their other liquids are less viscous (faster) than jam but they don't know where to put them in relation to tomato sauce and moisturiser.	 Group 2 from left to right: sunscreen, BBQ sauce, honey, jam.
Group 3 adds more liquids. Tomato sauce can be used as a reference point.	 Group 3 from left to right: shampoo, yoghurt, honey, tomato sauce.
Group 4 has several pieces of information that are useful. They know that bbq sauce is between yoghurt and honey. They also know that honey is between tomato sauce and bbq sauce.	 Group 4 from left to right: yoghurt, bbq sauce, honey, tomato sauce.

This process can continue until the class has enough information to make a complete list of liquids organised in order from least to most viscous, as shown at right.

It is important that students share only the rankings for their liquids and do not tell the other groups the actual timings they recorded, which will require some significant reasoning from the students. They will need to justify their placement of each item based on what they know about the liquids on either side of it.

Once you have an agreed order of viscosity, ask groups to estimate the timings for the liquids that they did not measure. Ask groups that did test those liquids to confirm the accuracy of the estimates.


Liquids in order from least to most viscous

1. shampoo
2. yoghurt
3. sunscreen
4. conditioner
5. BBQ sauce
6. honey
7. tomato sauce
8. moisturiser
9. sweet chilli sauce
10. cleaning fluid
11. golden syrup
12. treacle

Recording Sheet

Name: _____

Name of liquid	Predicted ranking 1 to 12 (1 = fastest; 12 = slowest)	Time to travel 10 cm	Actual ranking 1 to 12 (1 = fastest; 12 = slowest)

Observations: