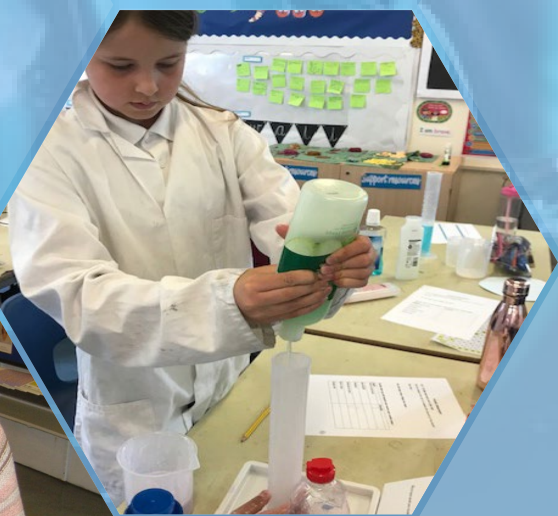
RUNNY LIQUIDS

A science investigation pack for teachers of 7-9 year olds



CENTRE for INDUSTRY EDUCATION COLLABORATION

Supported by the Gatsby Charitable Foundation

Contents

Introduction

AGE RANGE

The activities in this book provide an opportunity for children to think about the properties of liquids, and in particular, their 'degree of runniness' or viscosity. They are written for use with Years 4-5 children, and can be adapted for use with Year 6.

CONTEXT

The activities use a real life context, of a company producing a thick solution that needs stirring. The context- led activities are grounded in the Key Stage 2 National Curriculum for Science, with particular attention given to developing investigative skills.

Note: *This information is for the teacher. If shared with the class, it should be simplified* ***considerably.*** Many industrial processes involve handling and moving materials that may be very viscous (thick), and some can be almost solid on arrival at the site. These materials usually have to be converted into liquid forms before they can be moved around the site and take part in processes. Wherever possible, companies do this simply, by either heating or diluting the substance so the resulting liquids can be pumped around the site in pipes. Vessels and pipes containing hot liquids are therefore well insulated.

One chemical company uses a substance derived from wood resin (and can be from soya beans) as an 'ingredient' in printing ink resins, used for printing sweet and other similar wrappers. It is also the base for the glue used to seal the wrappers. The substance arrives on site in drums as a very thick liquid, which is warmed with steam in order to move it to storage tanks and reactors. Where possible, companies will use a free transfer method: gravity. The warmed liquid simply falls through pipes from one place to another.

Occasionally, companies add an ingredient to the material to reduce its viscosity. The company mentioned above is one of the biggest producers of additives called peptisers, that are added to rubber. Rubber is made from very long chains of particles (molecules). These chains tend to tangle up, like long strands of spaghetti, causing the liquid to be sticky. Adding a peptiser breaks up the long spaghetti-like strands and the liquid becomes runny again, because the small molecules can move easily around each other, rather like grains of sand or salt. Later in the rubber-making process, the chains of molecules re-join (polymerise) and regain their rubber-like properties.

In many cases, the viscosity, or stickiness, of the liquid must be measured to ensure that it meets the required specifications. Four methods are used in industry, measuring time taken for:

- a liquid to be poured through a funnel
- a ball bearing to fall to the bottom of a tall container of liquid
- a small quantity of liquid to run down a tilted tray
- an air bubble to reach the top of an inverted tube of liquid (or two tubes containing different liquids are turned together and the rate of rise of the bubble compared; one is the 'control').

ACTIVITIES

The activities should take about 5 1⁄2 hours to complete (in 3 sessions). The activities should be completed in the order given, for they develop an investigation from identification of a problem, investigating the problem, to a solution.

Appendix 1 provides an assessment grid for one investigation: the Runny measuring activity. It is intended to provide a practical example of how to assess an investigation.

The Activity sheets should help the children record their findings. At Key Stage 2 children are expected to '*...talk about their work and its significance, and communicate ideas using a wide range of scientific language, conventional diagrams, charts and graphs*'. It is hoped that the formats will increase the children's enjoyment of science by appreciating the variety of ways in which they can record their work. The formats are also intended to support differentiated teaching in the primary classroom.

ACTIVITY SUMMARY

Title	Description	Timing
1. Mixing muddle	The children classify a range of everyday liquids from water to shampoos, according to their physical properties.	40 mins
2. Runny measuring	Measurements of 'runniness' are made by timing a marble dropping through a cylinder of liquid, or by pouring liquid through a funnel and measuring the time taken.	75 mins
3. Changing runniness	A teacher demonstration to show the effect of warming liquids on viscosity.	60 mins
4. The challenge	Using cellulose paste, children make pastes of different viscosities which retain the property of sticking paper, but which do not run off the paper.	60 mins
5. The findings	Children write a letter to industry, based on their findings. They suggest ways to ease the stirring of liquids.	90 mins

Resource requirements

Quantities are given per group of 4 children, unless otherwise stated:

ACTIVITY 1

- Activity sheets 1 and 2
- Small pop bottles – 280 ml or 330 ml sizes
- Range of liquids from viscous to runny; 1-2 liquids from each column below:

Very thick	Medium	Runny
Baby shampoo	Washing-up liquid	Water
Shower gel	Baby shampoo	Vinegar
Foam bath	Fabric conditioner	Window cleaner
Cellulose paste	Fairy Colour	Fizzy drinks
Tomato sauce*	Vegetable cooking oil	
Salad cream*		
Golden syrup*		

* *These tend to be rather messy, so are suggested as second choices.*

ACTIVITY 2

- Activity sheets 4-5
- Stop clock or stopwatch
- 3 x 250 ml measuring cylinders
- 3 pop bottles (280 ml or 330 ml size)
- 3+ liquids, 'very thick' to 'runny' (see table, page 9)

Option 1*	Option 2
1 marble (standard size)	3 funnels[1]
250 ml samples of all liquids	50 ml samples of all liquids
from 'very thick' to 'runny'	in labelled yogurt pots

**Quickest, and closest to industrial practice.*

ACTIVITY 3

- Activity sheet 6
- 50 ml sample of a thick liquid e.g. foam bath, shampoo, shower gel
- Plastic coffee cup with holder
- Baby Belling/kettle

1 If possible use funnels of similar diameter 'tube', for a fair test. If you do not have access to funnels, these can be made by cutting the top off plastic water/pop bottles just below the 'shoulder'. These should have a screw top. Using a 4 mm drill, a hole can be drilled in the plastic screw top, before replacing on the bottle top.

ACTIVITY 4

- Activity sheet 7
- 25 ml of the very thick cellulose paste (7 g/500 ml water recipe)
- Stirrers or spoons
- Pipette
- Measuring cylinder (250 ml or 100 ml)
- Marble
- 100ml water
- Stop clock

ACTIVITY 5

- Computer with word processing software

1. Mixing muddle

40 mins

The children classify a range of everyday liquids from water to shampoos, according to their physical properties.

OBJECTIVES

- Compare and group materials together, according to whether they are solids, liquids or gases.
- To recognise the characteristics of a liquid.
- To classify a range of liquids according to properties.
- Identifying differences, similarities or changes related to simple scientific ideas and processes.

RESOURCES

(Per group of 4 children unless otherwise stated)

- Activity sheets 1-3
- Small pop bottles – 280 ml or 330 ml[1] sizes
- Range of liquids from viscous to runny; 1-2 liquids from each column below:

Very thick	**Medium**	**Runny**
Baby shampoo	Washing-up liquid	Water
Shower gel	Baby shampoo	Vinegar
Foam bath	Fabric conditioner	Window cleaner
Cellulose paste	Fairy Colour	Fizzy drinks
Tomato sauce*	Vegetable cooking oil	
Salad cream*		
Golden syrup*		

* *These tend to be rather messy, so are suggested as second choices.*

ADVANCE PREPARATION

Cellulose paste (e.g. PlayArt by Scola) is best made up previously, and diluted to the required consistency. For a very thick consistency i.e. a spoon will stand up in it, use a rounded dessert spoon of powder per pint water (approx. 7 g powder per 500 ml water). Stir the powder into the water for a minute, and allow to stand for 10 minutes. Stir again for a minute and the mixture is ready for use.

Pour 100 ml of each of the liquids into separate, clean and dry small pop bottles, and secure the top. Label and number the contents.

1 Throughout these notes millilitres ml are used rather than cubic centimetres cm3. They are virtually identical in volume, although the millilitre is not the internationally recognized unit of volume.

INTRODUCING THE ACTIVITY (10 - 15 MINUTES)

Read the letter provided on Activity sheet 1 to set the scene and identify the problem. Discuss the letter with the class, asking questions such as:

- Why does the company need the material as a liquid?
- What are the advantages/disadvantages of this type of material?

Ask the children to write down anything they know about liquids, no matter how simple. The concept map on Activity sheet 2 allows the children to link ideas related to solids and liquids, and is a useful guide for the teacher as to any misconceptions the children may have. Activity sheet 3 gives an opportunity for the children to record their results visually. Alternatively, responses can be written on the board, or large sheets of sugar paper, for reference during the work.

Safety note

Do not leave old labels on pop bottles. A child may think the new contents are the old.

MAIN ACTIVITY (15 - 20 MINUTES)

Ask the children to try sorting the bottles of liquids into groups. This can be done by placing P.E. hoops on the floor with labels, and placing the bottles in the appropriate hoop. Their criteria may be colour, purpose, smell, runniness, etc. Ask the groups to list the different ways they have sorted the materials. In the context of the problem, which of the sorting criteria would be most useful? The company is having problems with the stirring and runniness of their liquid, so questions to pose could include:

- Will the colour of the liquid have any effect on its ease of stirring?
- Does the smell of the liquid affect its runniness?
- Does the use of the liquid have an effect on its ease of stirring?

Point out to the children that colour, smell, etc. are valid sorting criteria, but in this context, runniness is the important property to investigate.

Using the results of those groups who have used 'runniness' as their criteria, line up the liquids in order of 'runniness' and list them. Activity sheet 3 can be useful for less able children, by writing the names on the pictures of pop bottles in the same order as the line-up of bottles.

PLENARY (5 MINUTES)

The plenary should establish that liquids flow, with varying ease, and take up the shape of their container. Questions to provoke discussion can include:

- *Is shower gel a liquid?*
  It flows, so can be classed as a liquid, but a very thick one.
- *What makes all liquids the same?*
  Liquids flow, and take the shape of the container they are poured into.
- *What makes liquids different from solids?*
  Liquids flow, and change shape. Solids cannot change shape.

Industrial Polymer Resins Ltd.

Consett
County Durham

Dear Research Group,

We produce special inks for chocolate-makers, who use them to print the names of sweets on the wrappers. We also make the glue for sticking the wrappers together. We have found that the best starting ingredient for the ink and glue is a liquid from trees. Unfortunately, our new recipe is causing us problems. It makes a very thick liquid that does not flow easily through our pipes. It is also very hard to stir, and we need a lot of electricity to run our stirring machines. This is very expensive!

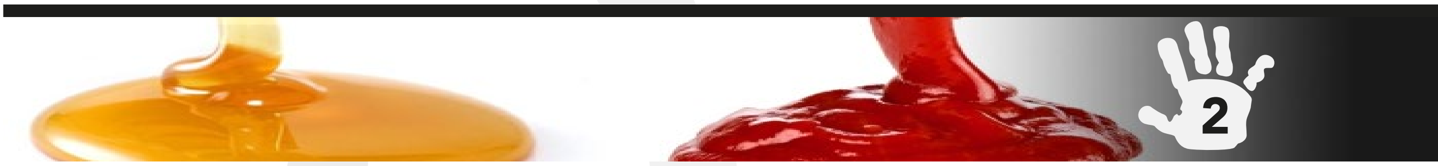
We understand that your research group is investigating liquids, and would be pleased if you could suggest ways we can solve this problem. We need as much data as you can provide, including any measurements you make of runniness of different sorts of liquid. Any suggestions you can give us, which will make our liquid flow more easily, would help us very much.

We look forward to hearing from you in the near future.

J. Wellington

J. Wellington
Managing Director

Activity Sheet 2: Concept Map



What do we know about liquids and solids?

pour

cold

smooth

shape

wet

flow

LIQUIDS

SOLIDS

dry

dissolve

soft

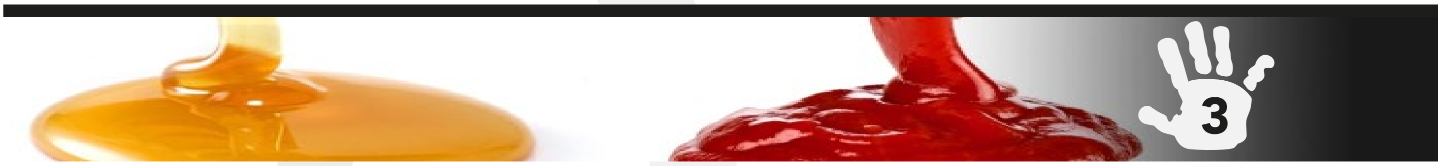
hard

rough

heat

melt

Activity Sheet 3: Sorting our liquids



1. Cut out the bottle shapes.
2. Write the name of each liquid on a bottle label.
3. Stick them onto a strip of card in order of runniness.

2. Runny measuring

75 mins

Measurements of 'runniness' are made by timing a marble dropping through a cylinder of liquid, or by pouring liquid through a funnel and measuring the time taken.

OBJECTIVES

- Compare and group materials together, according to whether they are solids, liquids or gases.
- To show that all liquids do not flow at the same rate.
- To measure the 'runniness' of liquids, and make comparisons.
- Gathering, recording, classifying and presenting data in a variety of ways to help in answering questions

RESOURCES

(Per group of 4 children unless otherwise stated)

- Activity sheets 4-5
- Stop clock or stopwatch
- 3 x 250 ml measuring cylinders
- 3 pop bottles (280 ml or 330 ml size) 3+ liquids, 'very thick' to 'runny'

Safety note

Some of the liquids have quite strong smells. Open windows to allow air to circulate.

Option 1*	**Option 2**
1 marble (standard size)	3 funnels[1]
250 ml samples of all liquids	50 ml samples of all liquids
from 'very thick' to 'runny'	in labelled yogurt pots

**Quickest, and closest to industrial practice.*

INTRODUCING THE ACTIVITY (15 MINUTES)

Refer to the letter and point out that the company wants assistance to solve the problem, and that the company want to move the liquid around the site in pipes. Discuss methods of measuring 'how runny' the liquids are. Questions could include:

1 If possible use funnels of similar diameter 'tube', for a fair test. If you do not have access to funnels, these can be made by cutting the top off plastic water/pop bottles just below the 'shoulder'. These should have a screw top. Using a 4 mm drill, a hole can be drilled in the plastic screw top, before replacing on the bottle top.

- How would they compare, say, salad cream coming out of a bottle with washing up liquid?
- Is it enough to say 'This is slower than that?'
- Would it be useful to tell the company how slowly each liquid flows?
- What would you need to measure to decide how quickly liquids flow?
- How can you present the information you get to the company so that they can see at a glance which is the quickest/slowest?

Lead the discussion to the idea of letting something fall through the liquid and measuring the time taken for the object to fall to the bottom of the container, or letting the liquids flow through a narrow pipe, e.g. a funnel, and timing how long it takes for a given amount of liquid to fall through.

MAIN ACTIVITY (40 MINUTES)

Two investigations are described below, though other ideas suggested by the children could also be investigated.

Option 1 will take less time to complete than Option 2, and is commonly used by industry. It is therefore suggested that this is the main method used. However, depending on class ability, it could be that some children test each option, and the results compared. In both options, the children need to be able to measure time taken. A stop clock is preferable to a stopwatch, as only whole seconds are measured.

Recording sheets are provided for both options, with a space for the children's predictions. Activity sheet 4 encourages them to tabulate their results and draw conclusions from their findings. Activity sheet 5 gives an opportunity to produce a bar chart of the results, giving a visual presentation of the numbers. Alternatively, children could construct their own block graph or bar charts. Block graphs can be constructed on 1-2 cm2 paper with gummed coloured squares, each representing, say, 10 seconds. (Squares can be cut down to represent shorter times when necessary). Each bar could be a different colour. This could be either a group or class recording activity.

Option 1: Timing a marble falling through a column of liquid.

Each measuring cylinder is filled with 250 ml of liquid, allowing space for the marble to displace some liquid. Dangle the marble just above the surface of the first liquid, drop it and start the clock[1]. Stop the clock when the marble hits the bottom, and record the time. Repeat the experiment with the remaining liquids.

Option 2: Timing liquid flowing through a funnel into a bottle.

A funnel is placed in the pop bottle, and the measured sample poured in quickly. Encourage the children to think about when to 'stop the clock'. Should they wait until every last drop has drained through? (It is suggested that the clock is 'stopped' when the flow turns to drops otherwise there could be a very long wait!). This process encourages the children to consider a reasonable stop point, and to keep it the same for each liquid.

1 If repeat tests are to be carried out, the marble could have a thread attached to it with Blu-tack or similar for ease of retrieval. The Blu-tack can loosen after each test. To help prevent this, re-attach the Blu-tack before each test, rolling it between the fingers to make it sticky again.

Some sample results for both methods are given below.

This table of results is for teacher information only.

Liquid	Time taken to pour through funnel (secs)	Time taken for marble to fall (secs)
Water	2	1
Vinegar	2	1
Window cleaner	2	1
Fabric conditioner	15	2
Fairy Colour	18	2
Washing-up liquid	20	3
Baby shampoo	25	4
PlayArt paste (5 g /500 ml)	65	20
Shower gel	183	24
Foam bath	185	24

As these results indicate, there is sufficient difference between runny, medium and thick liquids to be able to classify them by either method. If both options have been used, as mentioned above, the groups can compare results as part of their 'considering the evidence' work. The cellulose paste can then become a useful discussion point. Should it be grouped in the 'very thick' or 'medium runny' sets? The marble test would suggest the former, but the pouring test could suggest the latter. They may even suggest having another group, or subdividing them.

EXTENSION ACTIVITY

For more able pupils, a development of the marble experiment could use a ball of plasticine with thread embedded in it in place of the marble. (Plasticine would be recommended here, not Blu-tack, as it is a denser material.) This method gives another option, in that the shape of the plasticine can be changed. This allows comparisons between different shapes, which can enable children to consider the friction between the shape and the liquid flowing past.

PLENARY (20 MINUTES)

It is important to collate the results and look for patterns. As suggested above, the results can be displayed as a class block graph and then used for class discussion. Useful questions to raise with the children include the following:

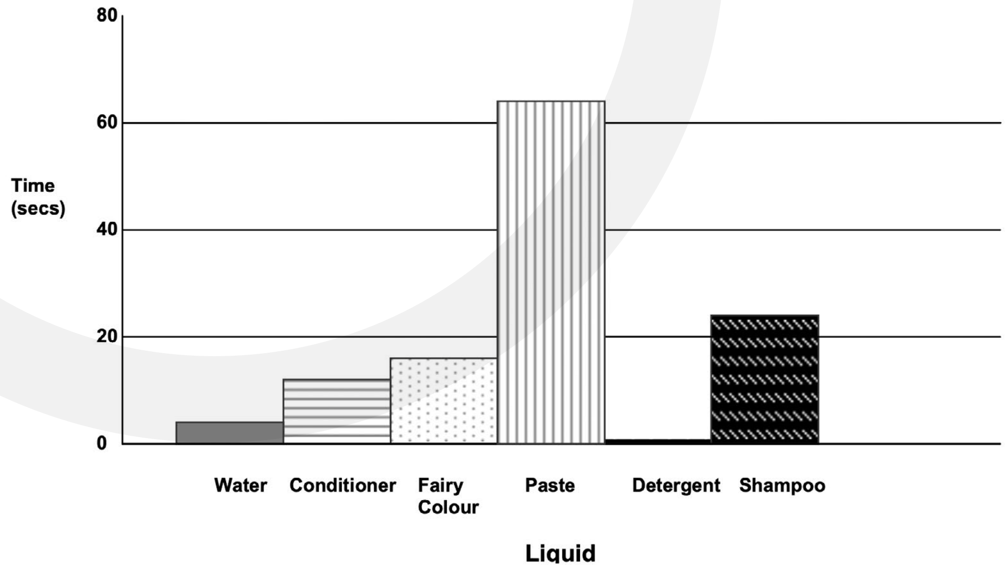
- *Do the times taken show the runny, medium and thick liquids?*
- *If both methods have been used, are the two sets of results similar?*
- *Is there an advantage to having both sets of information to compare against each other?*
- *The industry asked for measurements to be provided. Will our data help the industry make some decisions about the sort of liquid they might like to produce? How might it be helpful?*
- *Why do you think industry may prefer to use the 'marble method' to measure runniness of liquids?* Possible suggestions could relate to the time taken to complete the tests, and its simplicity.

The children can use ICT to record their results. A spreadsheet could be set up to record the data in a table, and the charting wizard used to produce bar charts of the results. This encourages children to use the software to put the data in order, either ascending or descending, rather than haphazardly. This is an important skill to learn in this context. Two examples of the type of software which could be used in the primary school are the NGfL program First Workshop, or the RM Windowbox program Starting Graphs. In this latter case, illustrated overleaf, the following sequence of operations produces the graphs.

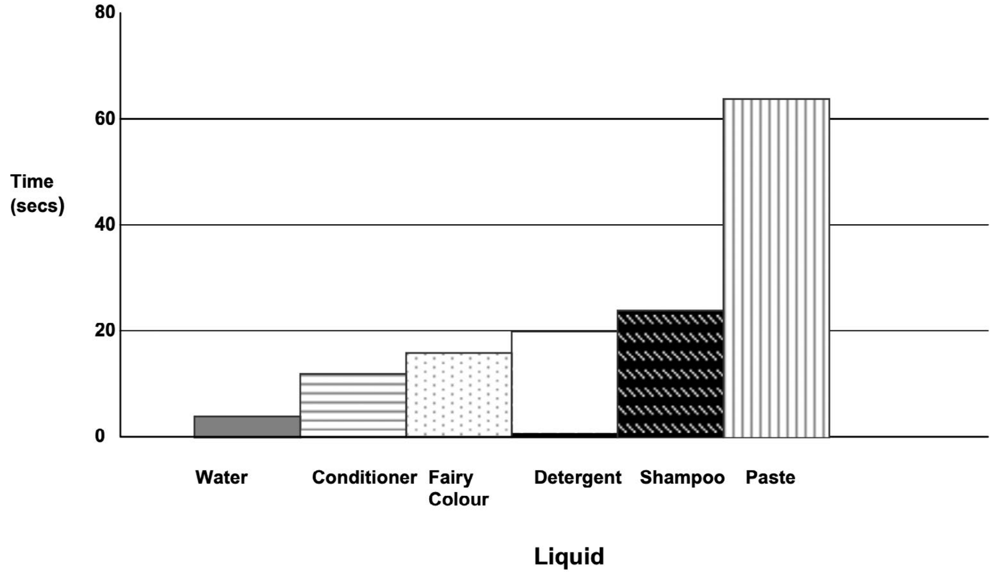
1. Click on New Project.
2. Set up the two columns presented with the labels Liquid and Time taken, filling in the data from their results.
3. They can choose the appropriate graph type from a range given.
4. Sort in ascending or descending order. The time scale automatically changes to accommodate the numbers typed into the column.

The illustrations below show the type of result obtained with this program, the first graph showing the unsorted data, the second one showing the results of sorting in ascending order of time.

Graph showing time taken for liquid to pour through a funnel



Graph showing time taken for liquid to pour through a funnel



Similarly, the following examples illustrate what could be done using MS Excel, which could be set up previously by the teacher for Year 4 children if they are not entirely familiar with the program.

1. The table is typed, with the headings, in Microsoft Excel, as shown below:
2. Highlight the chart by clicking and dragging across the table.

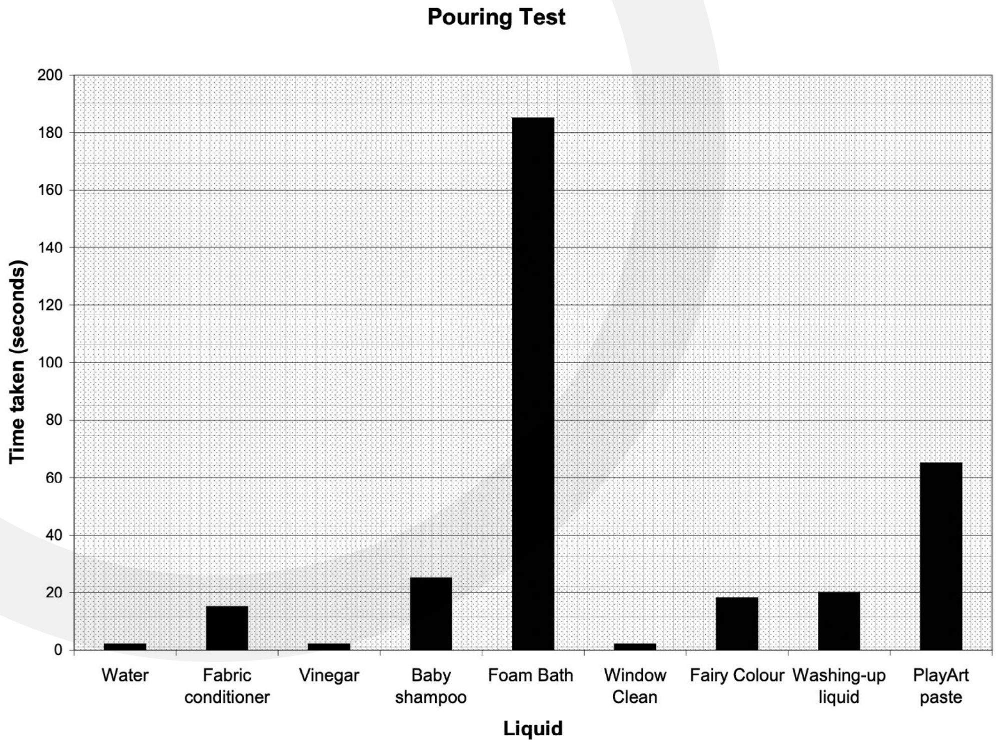
Liquid	Time taken to pour through funnel (secs)
Water	2
Fabric conditioner	15
Vinegar	2
Baby shampoo	25
Foam bath liquid	185
Window cleaner	2
Fairy Colour	18
Washing-up	20
Play Art paste	65

3. Click on the Chart Wizard button on the Menu bar.
4. From the options given, choose the type of graph required (a column graph in this case). Clicking and holding down the mouse button on the bar below the options gives a view of the graph that will be produced.
   Click Next.
5. Leave the data range unchanged and click Next.
6. Type the title and labels for the two axes in the spaces provided, if required.
   Click Next.
7. Check the button labelled As new sheet to produce a separate graph from the table. Click on Finish.

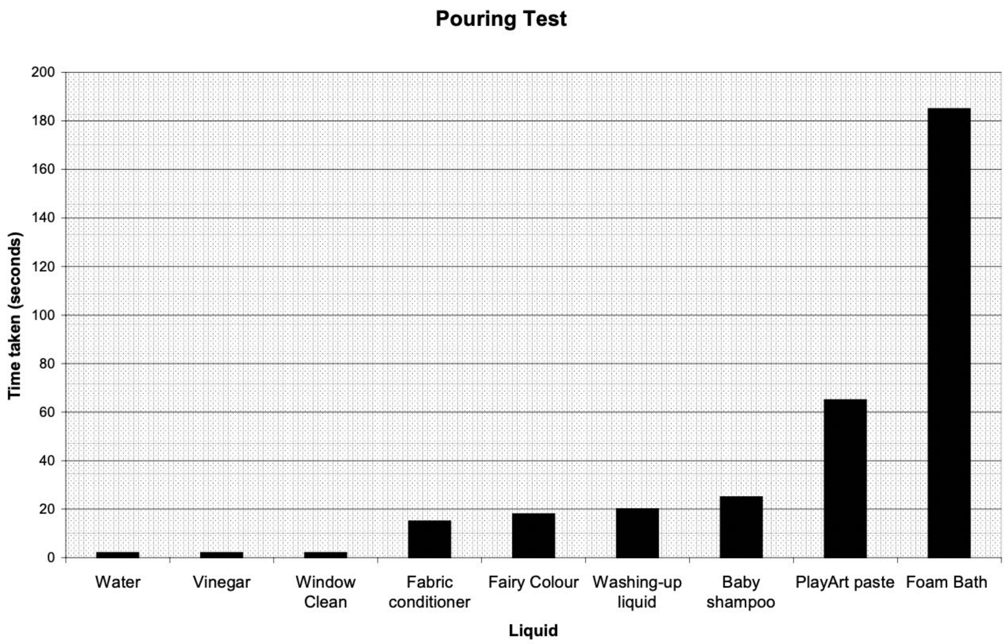
If the column of times and the heading is highlighted, the results can be sorted into ascending or descending order.

1. Click on Tools on the Menu bar.
2. Click Sort..., Ascending (or Descending), and the table will re-order according to the type of sort.
3. Clicking on the Chart tab at the bottom of the spreadsheet will display the chart with the results also re-ordered. Any change to the table is immediately reflected in the chart.

These results have been charted in the order shown, as shown overleaf.



As with the previous program, the data can be sorted in either ascending or descending order of time.



Activity Sheet 4: Measuring runniness

We predict that ____

____

____

Drawing of our test

Our results

Each time, we used ________ millilitres of liquid.

Liquid Name	Time taken (seconds)

Our results show that ____

____

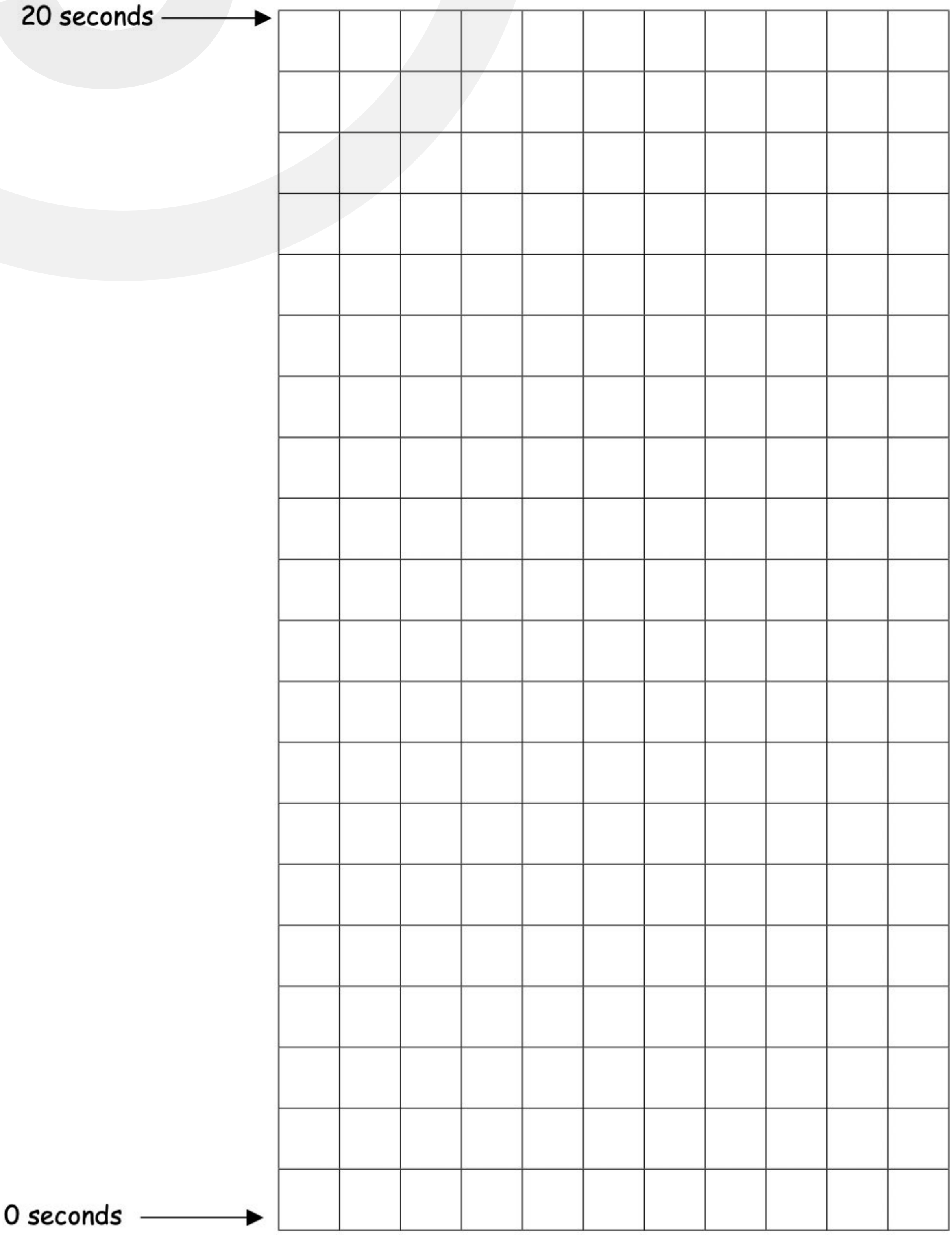
____

____

Activity Sheet 5: Measuring runniness

Bar Chart

Colour a column to the correct height (time taken) for each liquid you tested.



3. Changing runniness

60 mins

A teacher demonstration to show the effect of warming liquids on viscosity.

OBJECTIVES

- To show that the runniness of a liquid can be changed by warming.
- Observe that some materials change state when they are heated or cooled.

RESOURCES

(Per group of 4 children unless otherwise stated)

- Activity sheet 6
- 50 ml sample of a thick liquid e.g. foam bath, shampoo, shower gel
- Plastic coffee cup with holder
- Baby Belling/kettle

INTRODUCING THE ACTIVITY (5 MINUTES)

Remind the children of the letter and the request for assistance. Can they suggest ways liquids be made more runny? Questions to encourage discussion include:

- How could gravy/custard be made runnier?
- How could ice cream be made easier to scoop out of its container from the freezer?
- How can butter be made to spread more easily?
- How can acrylic paints be made thinner?

Gather the children's ideas and introduce the idea of warming the liquid if it has not been suggested. Discuss the validity of all the ideas presented. Hopefully, children will refer to their previous test; dropping a marble into a measuring cylinder of liquid, or pouring liquid through a funnel. Ask them to think of ways to find out whether warming a liquid makes it runnier.

MAIN ACTIVITY (45 MINUTES)

For safety reasons, this activity may be best carried out as a teacher demonstration. If the children are to carry out the test, the liquids must be warmed by the teacher. Activity sheet 6 gives an opportunity for the children to predict what might happen to the runniness of the liquids after warming.

The cup of liquid is warmed in a pan of heated water, and its temperature checked with a thermometer (should be kept below 50° C). Once warmed, the sample of the liquid is tested for runniness by pouring through a funnel or by dropping a marble into it. The other samples are tested in the same way.

Safety note

It is recommended that the liquid temperature not exceed 50° C.

PLENARY (15 MINUTES)

This activity should establish that the warmer the liquid, the runnier it is. The results of the experiments can be displayed on a block graph in a similar way to the previous experiments.

Activity Sheet 6: Measuring runniness

If you warm liquids up, will they be runnier? What do you **predict** will happen to the time taken for the marble to fall through the liquid?

Our experiment results

Liquid Temperature (°C)	Liquid Name	Time taken (seconds)

Our results show that

4. The challenge!

60 mins

Using cellulose paste, children make pastes of different viscosities which retain the property of sticking paper, but which do not run off the paper.

OBJECTIVES

- To use the knowledge gained to solve a problem about runniness of paper paste
- Using straightforward scientific evidence to answer questions or to support their findings

RESOURCES

(Per group of 4 children unless otherwise stated)

- Activity sheet 7
- 25 ml of the very thick cellulose paste (7 g/500 ml water recipe)
- Stirrers or spoons
- Pipette
- Measuring cylinder (100 ml or 250 ml)
- Marble
- 100 ml water
- Stop clock

INTRODUCING THE ACTIVITY (5 MINUTES)

Challenge the children to produce a paper paste which retains its sticking properties without being so watery and runny that it will not dry in a reasonable time. The reason for using a diluted form of the paste has to do with the cost of the powder. Diluting the paste will make it go further. Referring to the letter, ask the children what they think they will need to be able to tell the company about their experiments? They should establish that they need to know how much thick paste they have started with, and how much water they add to make it the 'correct' runniness. When they have completed the challenge, they could also use their runniness measurements to find out where their sample fits on the 'runny scale'.

MAIN ACTIVITY (50 MINUTES)

Each group of children is given a sample of the prepared very thick paste and must dilute it to the consistency they think is ideal. Using a pipette, they add a pipetteful from the pot of water and stir it into the paste. A small sample of this is used to stick a square of paper onto a large sheet. The time taken for it to dry can be measured using the stop clock. They can continue diluting and sticking in this way until they think the sample is 'too thin'. Below each square they write the number of pipettes of water added. In this way, they can identify the paste that provides the optimum or best recipe for the company.

Finally, the teacher can scale their recipe up to 250 ml paste, and put it into a measuring cylinder so that they can use the 'marble test' to find where their paste fits on the runny scale.

PLENARY (5 MINUTES)

The plenary draws together their findings from the investigation. Discussion questions can include:

- Is there a point when the paste becomes unusable?
- Why is it unusable? Is it too thin and runny, or does it take too long to dry?
- What information can they give the company about saving money by diluting the mixture?

Activity Sheet 7: The 'Paste challenge'

Record sheet

Stick pieces of paper in the squares to see whether your paste works. Fill in the boxes for each paste mixture, with the drying time and the pipettes of water used.

Number 1

Drying time

_______min

_____ pipetteful of water.

Number 2

Drying time

_______min

_____ pipetteful of water.

Number 3

Drying time

_______min

_____ pipetteful of water.

Number 4

Drying time

_______min

_____ pipetteful of water.

Number 5

Drying time

_______min

_____ pipetteful of water.

Number 6

Drying time

_______min

_____ pipetteful of water.

5. The findings

90 mins

Children write a letter to industry, based on their findings. They suggest ways to ease the stirring of liquids.

OBJECTIVES

- Reporting on findings from enquiries, including oral and written explanations, displays or presentations of results and conclusions

INTRODUCTION (20 MINUTES)

It is important to draw together all the work done in these activities. The work has introduced the children to properties of liquids, such as the ability to take up the shape of the container into which they are put. It has drawn their attention to different liquids having differing thicknesses (viscosities). Ask some of the following questions, some of which are repeated from earlier activities:

- *What makes all liquids the same?* Liquids flow.
- *How are liquids different from solid things?* Liquids take the shape of the container.
- *How can the runniness of 'thick' liquids be changed?*
- *Are there times when thick liquids are useful?* Can they give some examples of thick liquids which are used in everyday life? Glues, paints, custard, tomato ketchup.
- *Why are thick liquids sometimes useful?* Non-drip paints; glue stays where it is put!
- *When is it more useful to have thin liquids?* When liquids need to be transported through pipelines, or stirred; car engine oil needs to flow easily around the pistons at any temperature, even in very cold countries.

This activity can be carried out in Literacy or ICT lessons. The latter can include word processing, cutting and pasting, and inserting bar charts into reports. Using their knowledge and understanding of measuring and changing runniness, they can advise the company of their findings, as requested in the letter, which asked what the company could do to reduce the effort and energy used to stir or move a liquid.

The children should decide on the format of a letter or e- mail, and consider the needs of the people to whom they are writing. They will need to ask the following questions:

- *Who are you writing to?* The Research Director of the company will be a scientist; the Managing Director may not be a scientist.
- *What sort of information will the person need?* The scientist will look for details of the investigations, and numerical results and graphs; the manager will be interested in general information about your findings.
- *What is the best order to put the information in?* The scientist will want the details of what you decided to do, why you made those decisions, and how you set up the investigation, while the manager will probably look for an overall summary of the work.

MAIN ACTIVITY (50 MINUTES)

Children can work in groups or individually to plan and produce their report. They prepare accompanying documents (or attachments) to validate their claims/ conclusions. Documents can include diagrams, tables, graphs, etc.

PLENARY (20 MINUTES)

Each group presents their letter/e-mail to the rest of the class.

Appendix 1: Runny Liquids - Runny measuring

Experimental and investigative science: Assessment of performance

Learning objective	Level 1	Level 2	Level 3	Level 4	Level 5
Planning 2c: What? Predicting/deciding what evidence to collect/ choosing equipment.		Describes what they think will happen when the marble is dropped into each liquid. *The marble will go fast in the water.*	Able to make simple predictions about how runny the liquids will be, some of which are based on scientific knowledge. *I think the marble will go faster in the water and slower in washin- up liquid because water is thinner.* Recognise why it is important to collect data to answer questions. *I need some results to show which is the runniest liquid.*	Able to predict which liquid will be runniest giving reasons based on scientific knowledge. *I think the water will be the runniest, because it will let the marble drop fastest through.* Selects suitable equipment and decides on adequate data to collect. *I need some measuring cylinders to put the liquids in and a timer to see how long it takes the marble to go through.*	Makes predictions based on scientific knowledge and understanding. *The shower gel will be the thickest liquid, because it will only allow the marble to drop slowly through.* Selects apparatus for a range of tasks and decides on appropriate data to collect. *I will use different liquids, measure the time it takes for a marble to go through, and repeat the activity to check the result.*
Obtaining evidence 2f: Making observations	Observes the methods used for testing the runniness of the liquids.	Makes observations and conclusions related to the teacher's suggested method. *The marble fell fast in the water.*	Makes relevant observations about the rates of drop for the marble. *The marble dropped faster in the vinegar than the shampoo.*	Makes a series of observations about the rates of drop for the marble. *The marble fell fastest in the fizzy drink, it was slower in the shampoo but slowest of all in the shower gel.*	Makes a series of repeated, accurate observations. *The marble took 1 second to drop through the water; next was the washing-up liquid at 3 seconds but slowest was foam bath at 24 seconds.*
Considering evidence 2i: Making comparisons/ identifying patterns	Able to describe runny and thick liquids. *The water is runny; the shampoo is gooey.*	Able to make simple comparisons. *The vinegar is runnier than the shower gel.*	Able to identify simple patterns in their observations. *The liquids that are runny let the marble drop faster.*	Able to identify patterns in their own observations. *The thicker the liquid, the slower the marble dropped through.*	Able to identify patterns in their observations and measurements, using appropriate scientific language. *The runnier the liquid, the less friction and the shorter the time taken for the marble to fall.*

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www.ciec.org.uk

or contact:

Centre for Industry Education Collaboration
CIEC Department of Chemistry
University of York
York
YO10 5DD

01904 322523

ciec@york.ac.uk

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Author – Bryan Jackson

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