**Testing friction**

You can test friction by measuring how far a 100g slotted mass slides.

An elastic band can be used to flick the mass across a table top.



Spreading small amounts of liquid over the table will change how far the mass will go.

**Safety**

Spilt liquid can make the floor slippery.

Wipe up spilt liquid straight away.

**Apparatus and materials**

* 100g mass
* elastic band
* washable-marker pen
* metre rule
* cooking oil
* washing-up liquid
* water

**Procedure**

1. Practise flicking the mass to make it slide about 50cm
2. Mark where you put your fingers and the mass
3. Flick the mass again and measure how far it goes
4. Rub a small amount of cooking oil onto your table to make a thin layer
5. Flick the mass **in the same way** and measure how far it goes
6. Rub in some washing-up liquid and measure again
7. Rub in some water and measure for the last time
8. Dry your table

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**Predict**

What do you think will happen to the stopping distance with each liquid?

**Explain**

Explain why you think this will happen.

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| --- |
| **Carry out the investigation and record your measurements** |

**Observe**

Record all your measurements

**Explain**

Did you predict when the mass had the least friction? And when it had the most friction?

Explain why you think it had different amounts of friction with different liquids.

*Physics > Big idea PFM: Forces and motion > Topic PFM1: Forces > Key concept PFM1.4: Friction*

|  |
| --- |
| **Response activity** |
| **Testing friction** |

**Overview**

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| --- | --- |
| Learning focus: | Friction is a force generated by an interaction between two surfaces, and which acts to resist movement between them. |
| Observable learning outcome: | * Describe the cause of friction between two objects. * Explain how lubricants can reduce friction. |
| Activity type: | Response, predict, explain, observe, explain - practical |
| Key words: | Friction, surface, rough, lubrication |

This activity can help develop students’ understanding by addressing the sticking-points revealed by the following diagnostic questions:

* Diagnostic question: Making friction
* Diagnostic question: Stopping in the rain

**What does the research say?**

Friction is the force generated *by* an interaction between two objects. This is different to most forces which *cause* the interaction (Hart, 2002). This perhaps led to the finding from a study of thirty-eight 12-16 year olds, that fewer than half of students identify friction as a force (Stead and Osborne, 1980). Driver *et al* (1994) suggest that many students think of forces only as ‘getting things going’ and not as ‘stopping things’.

A later study of forty-seven secondary students, by Stead and Osborne (1981), showed that students also think that:

* friction depends on movement (seventeen students)
* friction only happens between solids (twelve students)
* friction is directionless, as distinct from a force that opposes motion (a few students)

In Stead and Osborne’s 1980 study they found that half of 13-year old students also thought of friction as rubbing. But friction is also acting between objects that are not moving. Text books for 11-14 year old students often talk about shoes or tyres having a good grip. The implication is that the shoe or tyre ‘has a lot of friction’, which It does not. Rather it is good at *generating* friction when it is pushed along a surface, and often the friction it generates *prevents* it from moving.

This response activity students are challenged to use their understanding of how friction is caused and how lubricants work, to explain why different liquids affect the amount of friction differently.

**Ways to use this activity**

Students should complete this activity in pairs or small groups, and the focus should be on the discussions. It is through the discussions that students can check their understanding and rehearse their explanations.

To begin, each group should discuss the activity and use their scientific understanding, firstly to predict what they think will happen, and then to explain why they think they are going to be right. If students in any group cannot agree, you may be able to direct them with some careful questioning.

Students now carry out the practical.

After the practical each group should be given the opportunity to change, or improve their explanation. A good way to review your students’ thinking might be through a structured class discussion. You could ask several groups for their explanations and put these on the whiteboard. Then ask other groups to suggest which explanation is the most accurate and the most clearly expressed, and through careful questioning work up a clear ‘class explanation’.

A useful follow up is for individual students to then write down explanations in their own words – without reference to the class explanation on the board (i.e. cover it up).

Differentiation

The quality of the discussions can be improved with a careful selection of groups; or by allocating specific roles to students in the each group. For example, you may choose to select a student with strong prior knowledge as a scribe, and forbid them from contributing any of their own answers. They may question the others and only write down what they have been told. This strategy encourages contributions from more members of each group.

**Equipment**

For each student/pair/group:

* 100g mass
* elastic band
* washable-marker pen
* metre rule

For the class:

* cooking oil
* washing-up liquid
* water

**Technician notes**

The order in which the liquids are used is important. The washing-up liquid ‘clears away’ the oil, and the water ‘clears away’ the washing-up liquid, so at the end of the investigation the tables *should* be clean and dry.

It often helps to avoid undue mess if it is the teacher who adds small amounts of liquid to the tables from one central bottle, rather than allowing students to help themselves. This also makes it much easier to control the pace and focus of the activity.

**Health and safety**

Liquids can spill onto the floor and cause a slipping hazard. This risk can be reduced if only the teacher adds liquids to each table, and with a good supply of dry cloths.

Slotted masses can fall onto the floor and roll, resulting in students ‘chasing’ after them. A clear reminder of standard lab rules can be helpful.

Practical work should be carried out in accordance with local health and safety requirements, guidance from manufacturers and suppliers, and guidance available from CLEAPSS.

**Expected answers**

Results vary depending on the quantity of liquid added in each instance. There is no definitive answer as to which liquid reduces the friction the most, the purpose of this activity is to apply understanding to a new situation.

Friction is caused by small ‘bumps’ on the surfaces overlapping pushing on each other to oppose motion. Liquids can separate the surfaces so that fewer bumps engage. Different liquids have different consistencies which means their effect on friction varies with the situation. Oil is thicker and has more friction, but stays in place more easily. Water is thinner with less friction, but flows away more easily and forms a thinner layer.

This is also very good investigation for thinking about control variables. For example, the desk should be cleaned and dried between each measurement, the fingers exactly the same distance apart and so on. There are lots of control variables this investigation.

**Acknowledgments**

Developed by Peter Fairhurst (UYSEG).

Images: UYSEG

**References**

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