Friction

PTV learning outcomes

- Students are aware of the opportunities for using public transport
- Students understand why their actions are important to being **safe** on and around public transport

Duration

Sequences are intended to be delivered in 2–4 lessons.

Overview

In this learning sequence, students explore frictional forces. They investigate how friction changes with different contact surfaces in wet, dry and icy conditions, and the effect this has on braking. Finally they apply this learning to the real-world situation of tram, pedestrian, cyclist and car travel, and explore why sand is used on tram tracks in wet conditions

Students should have some basic understanding of forces as pushes and pulls, and the effects of forces on objects, especially how (unbalanced) force affects movement. The 'Student everyday experiences' and 'Critical teaching ideas' in https://www.education.vic.gov.au/school/teachers/teachingresources/discipline/science/continuum/Pages/friction.aspx are very useful to read before engaging in these activities with students. Note, in particular, the critical idea that friction is explained by tiny bumps on surfaces – like the non-slip tread on train platforms and stairs - this is especially useful when referring back to why sand is used in the trams scenario, the idea central to this sequence.

Curriculum alignment

Science Levels 3–4

VCSSU064
Forces can be exerted by one object on another through direct contact or from a distance

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Engage

Show students a zoomed-in image of the sand box reservoir window on a tram, like the one on the resource sheet. Ask: Who has seen one of these? What is it? What is it for?

Discuss ideas with the class, slowly zoom out, showing more of the window. This is an opportunity to gauge how much experience students have with trams, and to guide the discussion appropriately. Someone may recognise it, or it may help to zoom all the way out and show a tram from the outside. It may be necessary to zoom back in at this point to show the sand inside the window and guide discussion around what it may hold. If no one knows about the sand or what it is for, then explain that it's sand that trams carry to spread on the tracks in wet weather. Guide discussion around why this might be so.

Some students may not be regular users of public transport, including trams, so this may be a good opportunity to introduce some **safety** tips, common signage and familiarity with public transport in your area. Some ideas for exploring this:

- Introduce and display common **safety** and information signs in the classroom. Discuss with students what they mean (some will already know!) and familiarise students with the **safety** messages and how they help passengers find their way around.
- Set up a 'tram stop' in your classroom and role play/rehearse reading signs and timetables, watching for trams and **safely** entering and leaving trams.
- This can be followed by a class excursion to the nearest bus stop, train station or tram stop where students can practise being **safe** public transport users.

Explore

In exploring frictional forces, briefly review with the students that forces are pushes and pulls. Show the students the video, *The magic of friction* (https://fuse.education.vic.gov.au/Resource/LandingPage?ObjectId=e42ae37a-dc18-4486-bdc9-3806531f40aa&SearchScope=All) to highlight the idea that friction is a force between two surfaces that make contact. It is the force between surfaces that makes it difficult for them to move across each other.

To further explore how friction works between two surfaces, guide the students through a friction activity. Using the Friction Frog activity described at https://blog.doublehelix.csiro.au/friction-frog/ as a reference, encourage the students to create and decorate their own tram and explore the forces of friction. To create their tram, students will need:

- a 20 cm x 20 cm piece of cardboard
- two 5-cm long pieces of drinking straw
- string
- sticky tape
- scissors
- coloured pens, pencils, crayons, paints or textas
- other decorations.

Explain

How does friction work? How does this all help things slow down in wet/icy weather when there is potential **danger** of slipping and sliding?

Guide students as they further investigate how frictional forces change with different surfaces using a toy car and a ramp to demonstrate.

The experiment requires a toy car, a ramp, some books or blocks to change the incline of the ramp and several different surfaces. These might include tiles, linoleum, felt, carpeting or any other useful materials of varying texture for this experiment. Students can predict then measure the distance the toy car travels from the top of the ramp with each new surface, and discuss on which surface the toy car travels the smallest distance.

As each scenario is established with a different surface and different ramp inclines, students can be invited to make predictions and observations. They can also record their results and explain their conclusions.

Elaborate

But how does all of this relate to a braking tram?

Demonstrate braking distances using the learning object It's a drag (http://www.scootle.edu.au/ec/viewing/L51/L51/index.html#). Select a loaded truck as the closest in size and weight to a tram, and step through the interactive with the students, focusing on braking distance for dry/wet/icy surfaces at the same speed. Encourage a Predict, Observe, Explain discussion. Change only one variable at a time, to encourage a scientific approach and to avoid confusion. (*Note that this learning object is designed for older students and includes more complexity than is required in this sequence of learning.*)

Ask students how the tram situation is different to the trucks and cars they have used as models. In pairs, ask them to compare a truck with a tram and list similarities and differences in regard to the form of transport and to the surfaces on which it travels. Finally, they could draw a tram and a truck braking in wet weather and label ways to help them brake sooner. Refer back to the idea of 'tiny bumps on surfaces' to help explain how this works.

Students can also be asked to consider the **safety** aspects of a large, very heavy, moving tram and its capacity for braking in normal circumstances and in wet conditions. What behaviours are appropriate in these contexts if, for example, students are preparing to cross a road in front of a tram? To further support this discussion, students could search the internet for video content using keys phrases such as 'being alert around trams'.

Evaluate

Back to the sneaky box of sand! The sand box in trams is filled up at the depot, then dropped on the tracks in wet weather at corners and junctions where extra traction or grip is needed. The night-time tram sweepers come through and vacuum the sand up for re-use (students may have seen these). Give students (shuffled) images of the parts of the sand system on trams (as per list below) and ask them to sort them into time order and explain what they do:

- sand silos at tram depots
- sand being filled on trams
- sand window on tram
- sand trails on/in tram tracks
- sand being vacuumed up by the tramline street sweepers.

Ask students to design an information sheet, poster or short advertisement for other children on using trams in wet weather, explaining how trams brake in wet weather, what to carry on days it might rain, including **safety** concerns (make sure you hold on, take care when boarding and alighting trams on rainy days). These can be shared with other class members and possibly with younger students at school.

Students may wish to extend further by investigating friction in other contexts involving modes of transport – for example, choose a mode of transport and investigate:

- What systems do trains and cars use to help brake in wet weather?
- Do trains use sand boxes?
- How do cars and bikes cope with wet weather?
- How are tyres designed to help grip?