

# Forces and motion – friction is a force

Critical teaching ideas - Science Continuum F to 10

**Level:** Moving to level 4

## Student everyday experiences

One of the most obvious effects of friction for students is that it can lead to the gradual wearing away of things, for example the soles of our shoes, balding bicycle tyres and the deliberate action of rubbing sandpaper on a surface. Experiences of trying to walk, roller skate or ski on slippery surfaces such as ice or snow promote an understanding that getting moving and/or changing direction are both difficult to do in environments where friction is reduced. Friction is frequently portrayed in the popular media as having a “bad” effect and something to be reduced or eliminated (e.g. using friction reducing oils or non-stick fry pans).



However, in students’ everyday lives, friction is not itself seen as involving forces and nor is it seen as being present when things are not moving (e.g. a child who sits stationary halfway down a slide).

Friction is a confusing influence in our everyday experiences of motion, because people are often not aware that friction may contribute to the forces involved.

For those who think that things move because they contain a force that keeps them moving (See Pushes and Pulls) friction can be seen as responsible for gradually using up this force.

## The scientific view

Scientists are not completely sure what causes friction; however it is thought to be caused by the interactions between the tiny bumps on surfaces as they rub against one another.

The bumps on each surface bend and exert a force on each other making it hard for the surfaces to slip over each other. The force on the moving surface is in the opposite direction and resists the motion.

## Critical teaching ideas

A useful model for explaining friction is;

- The idea that all surfaces have tiny bumps.
- When two surfaces slide over one another the tiny bumps push on each other.
- Friction causes a force on a surface which is in the opposite direction to its motion.
- Friction can be reduced by the application of lubricants.

Friction can slow things down and stop stationary things from moving. In a frictionless world, more objects would be sliding about, clothes and shoes would be difficult to keep on

and it would be very difficult for people or cars to get moving or change direction. (See Mitchell, 2007)

Students should be encouraged to consider how dependant their world is on the beneficial action of friction. Not all friction is “bad” as we are frequently told. Encourage students to consider both the positive and negative effects of friction on their everyday actions and experiences. Ask students to identify what actions and tasks we do easily because of friction and what actions and tasks are made more difficult? (e.g. walking and surfing and snow skiing).

The idea that surfaces have tiny bumps provides a useful model for explaining the cause and effect of friction. Students should discuss this model in an attempt to build an understanding of what the microscopic surfaces may look like and how they interact with each other. (See Loughran Berry & Mulhall, 2006)

Sheets of fine sand paper or the soles of Dr Scholl’s sandals, provide students with a good visual model of what smooth surface may look like at the microscopic level.

Students should be encouraged to explain why, in terms of the model of surface bumps pushing against each other, applying oil or lubricant to the contact surfaces can reduce the friction and allow them to move more freely. Students should be encouraged to identify in which direction the friction force acts in a variety of simple situations and consider examples of everyday situations where friction is deliberately increased and reduced. Eg. The purpose of using hand grips and engine oils lubricants.

## **Teaching activities**

### **Focus students’ attention on hitherto overlooked detail.**

Students should be introduced to a variety of familiar situations involving friction where there is a focus on exploiting a frictional variation which may not be immediately apparent to students.

They could explore the reasons for the wide variation in the design of shoes and in particular the soles of shoes created for specific purposes (eg running, rock climbing, ice climbing, dancing, skating and bushwalking).

Encourage students to examine the frictional advantages of each of the designs. Consider how the shoes performance will alter as the sole is worn down with use over time.

### **Challenge some existing ideas.**

POE (Predict-Observe-Explain). Get students to predict what will happen, then observe the event and explain their observation in each situation:

1. A book is at rest on a flat piece of wood that is inclined at a small angle to a table. Gradually the angle between the wood and the table is increased.
2. Two similar blocks of dry soap are pushed across a smooth table top. For one block of soap the table is dry and for the other block the table has been wet with a water detergent mix. Ask students to compare the size of the pushing force required to make the bars move.

3. A student slides down a plastic slippery slide covered with water and then repeats the experience with a soapy solution spread across the surface.

(See Gunstone & Mitchell, 1998 and Loughran Berry & Mulhall, 2006)

**Clarify and consolidate ideas for/by communication to others.**

Students can explore and discuss situations where too little friction can present safety issues (e.g. wet or icy roads, wax on surfboards, smooth shoes, rubber gloves and handle grips) and those where too much friction means things don't work very well (e.g. moving parts in bicycles, rollerblades, skateboards, door locks and gate hinges). After exploratory discussion, invite students to write about what a world would look like without friction? How would it be different to our existing world? What tasks could still be done and what tasks would need to be done differently?

