Forces at work: Friction and grip

do more feel better live longer

Educator notes

Learning objectives

- Understanding that friction is the force that keeps an item from sliding along a surface
- Demonstrating the use of a force gauge/force meter to measure force in Newtons
- Showing friction and gravity in one dimension with force arrows
- Making predictions using scientific knowledge and understanding

Curriculum links

- Science (Physics)
  - Motion and forces
  - Working scientifically

Resources required

- Resource slides
- Friction and grip student sheet

Time needed: 40 minutes

This lesson builds on the learning from two other modules on forces: **Bounce** and **Drag and lift**. If you haven't delivered those modules yet, and your students haven't had any other lessons on those forces this activity may be quite challenging, though definitions of all these forces are included.

Equipment needed

- A force gauge (spring balance) that measures in newtons, with a 10N range
- Wooden board or similar, to use to create a ramp
- At least three different types of shoe*
- 1kg mass or heavy objects that you can place into the shoes

* You can ask the students to bring footwear in ahead of time, if you feel it's practical

Contents	Page
Introduction (15 mins)	2
Activity 1: Measuring friction (25 mins)	3

Forces at work: Friction and grip

do more feel better live longer

Educator notes

Slide 1
Friction and grip

- Explain to students that today the class will be learning about some of the science behind what affects movement of all things: forces
- The focus will be on the force of friction, which happens all around us and is particularly important in the sport of curling

Slide 2
Forces: Curling

- Describe the sport of curling, or watch the short video linked below, and in the slides
- Curlers have unique shoes – one is completely smooth, called the slider. The other has incredible grip allowing them to grip onto slippery ice
- When players sweep the ice, it heats up just enough that the friction force is reduced, and the stone slides further
- Explain that friction is a force that works when two objects move against each other, like a broom or stone on the ice, or shoes on the ground. Today's activity is all about friction

What is curling?
Curling is a team sport, played on ice, where two teams take it in turns to slide stones made of granite towards a target. When a team member delivers a stone, their teammates sweep the ice in front of it to extend its slide. Watch this short video if time permits.

Slide 3
How many different shoes can you think of?

- Ask students to think about all the different kinds of footwear they and their family have at home
- Encourage them to think beyond everyday footwear to specialist shoes like wellingtons, ballet shoes, snow boots, steel-capped boots, rock climbing shoes and mountaineering crampons

Slide 4
How well do these shoes grip?

- Tell the students to look at the soles of the shoes on the slide, and think about how shoes are optimised for the surface they're worn on
- Compare the following pairs of shoes in terms of their grip:
  a. Ballet shoes and flip flops
  b. Hiking boots and bowling shoes
  c. Football boots and wellingtons

Slide 5
Defining grip and friction

- Share the definition of friction with the class; explain that friction is the force that creates grip. The soles of your shoes are your only contact with the ground, and the only place where the forces controlling your contact with it are working, including friction
- Discuss what makes the footwear suitable for its activity, thinking about how we use materials, design and manufacturing processes to improve what our feet can do on their own. Use the shoes you have brought in as a starting point

Forces at work: Friction and grip

do more feel better live longer

Educator notes

Slide 6
Friction forces

- Explain that friction acts in the opposite direction to any force that attempts to move an object, as shown in the slide
- Students may ask about the tread of the shoes. Explain that tread allows any liquid to get out from between the floor and the shoes, which is the same reason that car tyres have tread. If tread wasn't there, on a wet surface, the water sitting between a shoe and the floor would mean there's little to no friction and the wearer would slide across the surface

Slide 7
What's missing?

- Ask students what force could be increased or decreased to change the amount of friction and grip

Slide 8 and 9
What's missing? Answers What does friction do?

- Explain that the answer is weight, which students should already know is a force caused by gravity
- Now ask them to discuss how having the right clothing and equipment can make a difference in various situations. For instance, adventurers using ice picks and crampons to climb mountains, having enough grip may be the difference between life and death. Move to **Slide 9** and explain that there's also a trade-off between grip and speed; friction slows you down

Slide 10
Lab activity: Measuring friction

- Let the class know that we will now be putting the shoes to the test and our learning into action to determine which shoes have the most friction

Activity 1
Measuring friction

25 mins

1. Inform students that they are going to investigate how well different shoes grip. Split the class into groups of up to five, based on the number of shoes you have available
2. Each group should start with one shoe then swap between groups to repeat the experiment. Ask students to look at the material of the sole of each of the different shoes and discuss which will have the most and least amount of grip
3. Explain that they will be using force meters to measure the force required to move the shoes along a surface, measured in newtons
4. Discuss this in terms of opposing forces; how the force applied must be greater than the friction acting on the item in order for it to move
5. Ask students if they can think of another way to test this, other than on a flat surface. Lead them towards the idea of pulling the shoes on a slope as well
6. Distribute the **Friction and grip student sheet**. The sheet contains details of the slope method, so avoid giving it out too early
7. Direct the students in their use of one or both of the following methods to measure friction. Instructions are also on the student sheets

Forces at work: Friction and grip

do more feel better live longer

Educator notes

Activity 1

Measuring friction Continued…

Optional: If it isn't possible to use both methods, you could extend Method 1 to further discuss the impact of gravity and weight by instructing students to conduct the experiment with and without the mass.

Method 1: Flat surface

1. Students should fill in the prediction section of their sheets, ranking shoes based on which they think will grip most
2. Begin with the shoe on a level surface (floor or bench)
3. If you have access to the 1kg mass, you can place them in the shoe now, or another heavy object
4. Next, the force meter should be used to slowly increase the horizontal force on the shoe until it just starts to slide
5. Students should record how many newtons were required to start the movement
6. Repeat three times and work out the average
7. Try each shoe, working out the average force for each one

Method 2: Slope

1. Students should create a ramp using a wooden board or similar. Set this up in a way that the height of the ramp can be changed, or if it's lightweight, team members can hold it at different heights
2. If you have access to the 1kg mass, students can place them in the shoe now, or use any appropriate heavy object
3. Next, the force meter should be used to apply force until the shoe starts moving down the ramp
4. Students record how many newtons were required to start the movement
5. They should repeat the tests three times and calculate the average
6. Students should try each shoe, working out the average for each one
7. Able students should be challenged to explain why a shoe slides down a steep slope but not a shallow one using the words friction, weight and force. This is a great opportunity to reinforce the idea of weight as a force caused by gravity

Extension/homework

Students could be challenged to produce graphs or charts of their results. The simplest approach is a separate bar chart for each method, with a bar showing the average "grip" for each shoe, but they could also choose to create a line graph showing all their tests for each shoe.

Try next: There are two modules which complement this one titled **Bounce** and **Drag and lift**, investigating other forces. They follow on well from this module and look at drag, lift and bounce in more detail, as well as experimental skills.

Additional information:

During the experiment, students will likely notice that there's a difference between the amount of force needed to start a shoe sliding and the amount needed to pull it along at a steady speed. Explain that this is because there are two forces at work: static friction, which keeps an object stationary, and kinetic friction which is the force acting on a moving object, as necessary.