Physics > Big idea PFM: Forces and motion > Topic PFM1: Forces

Key concept (age 11-14)
PFM1.4: Friction

What's the big idea?

A big idea in physics is force, because it is the key to explaining changes in the motion or the shape of an object. The motion of an object can be explained or predicted if you know the sizes and directions of all the forces that act on it. Understanding forces helps us to predict and control the physical world around us.

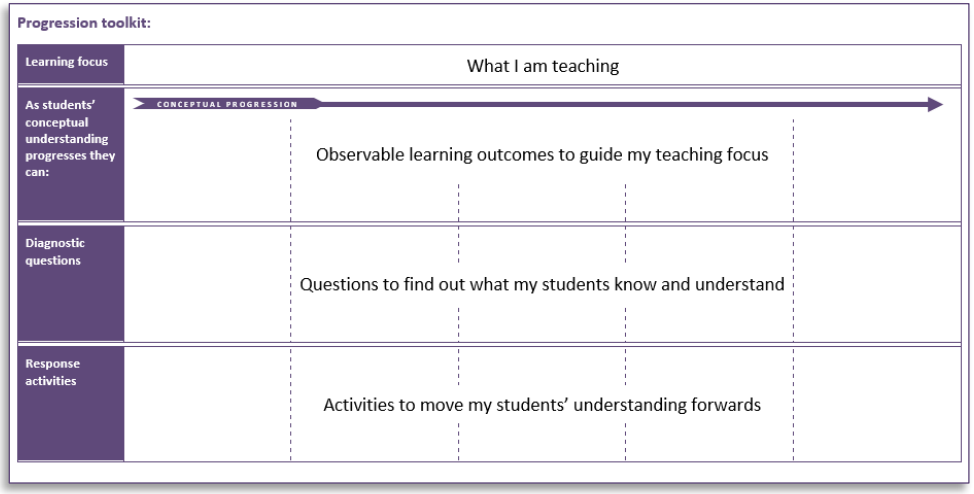
How does this key concept develop understanding of the big idea?

This key concept develops the big idea by building on the idea that friction acts when an object is pushed or pulled against a surface, in order to develop an understanding of friction as a force that opposes the motion of moving or static objects.

The conceptual progression starts by checking understanding of where friction is found. It then supports the development of ideas about the causes and nature of the force of friction in order to enable understanding of how friction acts on static objects to give them grip.

How can you use the progression toolkit to support student learning?

Use diagnostic questions to identify quickly where your students are in their conceptual progression. Then decide how to best focus and sequence your teaching. Use further diagnostic questions and response activities to move student understanding forwards.



Progression toolkit: Friction

Learning focus	Friction is a force generated by an interaction between two surfaces, and which acts to resist movement between them.				
As students' conceptual understanding progresses they can:	CONCEPTUAL PROGRESSION →				
	Identify places where the force of friction is acting. **P**	Describe the effect of the force of friction on an object.	Describe the cause of friction between two objects.	Explain how lubricants can reduce friction.	Explain how friction, generated by the interaction between two objects, can stop them from moving.
Diagnostic questions	Where's friction?	The force of friction	Making friction	Stopping in the rain	No friction
Response activities			Testing friction		Shoe slope

Key:

P Prior understanding from earlier stages of learning

What's the science story?

When a moving object slides over a fixed surface a force of friction acts on the object in the direction opposite to its motion. And when an object is pushed or pulled on a surface, by a force that cannot move it, a force of friction acts on the object in the direction opposite to the pushing or pulling force. The friction force is exerted by the surface which the object is sliding over, or by the surface which the object is trying to be slid over.

The friction force acting an object is caused by the unevenness at a microscopic level of the surfaces in contact. This leads to a force along the line of the interface, when an applied force makes an object slide (or attempts to make it slide) over another object. Friction can be reduced by using a liquid (a lubricant) to fill the tiny surface irregularities.

For a given object on a given surface, the friction force balances (cancels) the applied force that is trying to slide one object over the other, up to a limit (which depends on the weight of the object and on the surfaces in contact). If the applied force exceeds this limit, the object will start to move. Once an object starts to slide, the friction force acting on it remains the same size, regardless of its speed.

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 the same thing as reaction (nine 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.

The progression toolkit for friction reminds students that friction is a force that affects almost all of our physical actions. Students begin by identifying places where friction acts and by describing what the force of friction does. By considering the rough nature of surfaces and how lubricants act to separate

these, students are given the opportunity to develop a scientific model of friction. Analysing the effect of a static object on a slope challenges students to think about friction as a force generated by the interaction between two objects.

Guidance notes

Friction is a good key concept to use for developing practical skills.

References

Driver, R., Squires, A., Rushworth, P. and Wood-Robinson, V. (1994) Making sense of secondary science, research into children's ideas, Routledge, London, England.

Hart, C. (2002), Teaching Newton's laws as though the concepts are difficult, *Australian Science Teachers' Journal*, v48 n4 p14-23 Dec 2002.

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