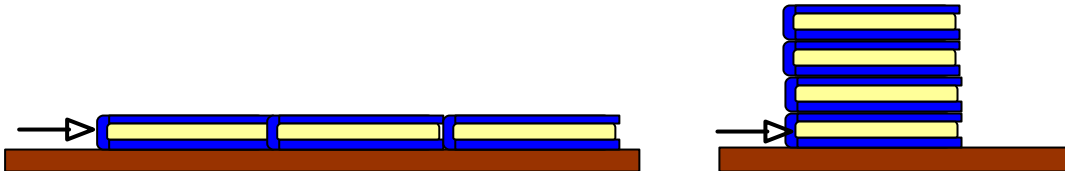


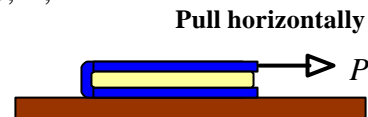
Investigating Friction

This is a practical activity. You will need: books, wooden block(s), masses, mass hanger, pulley and clamp (or an elastoscale).

- 1 Make a list of the factors which you think will influence a friction force. Investigate your ideas – you may wish to try using a number of books to do this.



- 2 (a) Sketch a graph showing how you think the friction force, F , varies with an increasing pulling force, P .

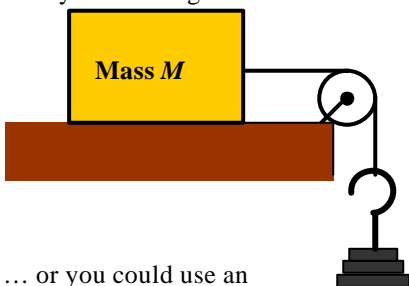


- (b) How does the general shape of your graph alter as the mass of the book is increased?

- 3 Investigate how the maximum friction force, F_{MAX} , varies with the normal contact force, N .

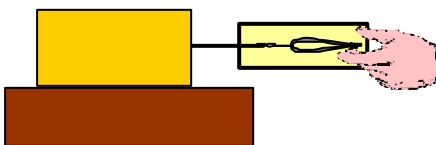
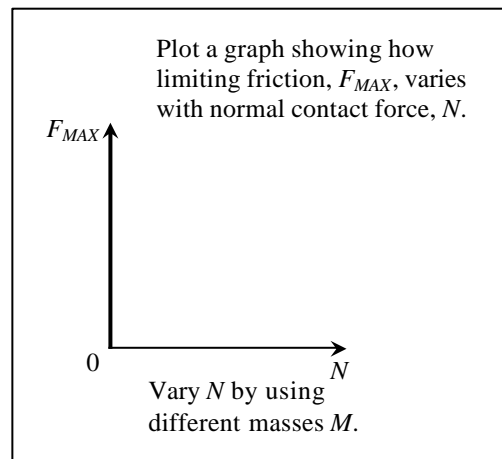
The maximum friction force, F_{MAX} , that can be reached between two surfaces in contact is known as **limiting friction**.

This type of practical apparatus may help your investigation



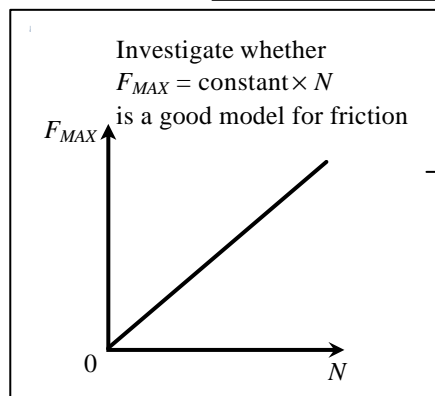
... or you could use an elastoscale ...

Add small masses until the block just starts to move



Make sure the block is in the same Position each time so that it experiences the same roughness.

Gently tap the surface to see if the block will start to move.



If the suggestion in this graph is valid, then, if you wish to increase the friction force, for example, between a car's tyres and the road, you need first to increase the normal contact force between the tyres and the road.



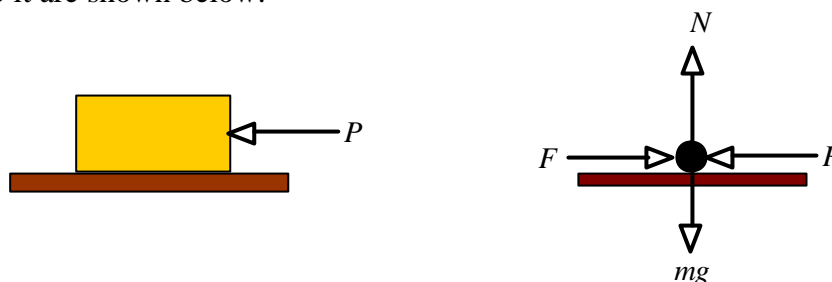
Modelling Friction Forces

Summary

Mathematicians use the model, $F = mN$ where F is the friction force acting between two surfaces in contact, m is a constant due to the nature of the two surfaces, and N is the normal contact force.

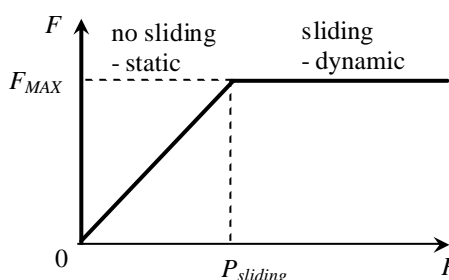
The constant m is called the **coefficient of friction**.

Consider a block at rest on a horizontal table. A force P is applied horizontally to the block in such a way as to attempt to slide the block along the table. The force P is gradually increased until sliding just occurs. This situation and a full force diagram relating to it are shown below:



- The frictional force, F , acts tangentially along the two surfaces in contact.
- When a force acts to move two surfaces in contact, the frictional force acts in a direction to oppose the motion.
- Before sliding takes place, the friction force increases and is equal in magnitude to the force, P , which is trying to cause sliding between the surfaces. This maintains the body in equilibrium.
- There is a maximum friction force F_{MAX} that can be achieved between two surfaces in contact.
- Just as sliding takes place, the friction force reaches its maximum value, F_{MAX} , so $P_{sliding} = F_{MAX}$
- When sliding is taking place $P \geq F_{MAX}$

A graph of F against P is as shown.



The coefficient of friction, m is constant for a given pair of surfaces in contact. In any situation in which friction is an important feature you will need to find experimentally a value for m for the pair of surfaces in contact.

When the bodies in contact are not moving the friction force F satisfies $F = F_{MAX}$; in this case $F = mN$. When the bodies are moving $F = mN$.



Teacher Notes

Unit Advanced Level, Dynamics

Notes on Activity

This activity originally appeared in the book *Mechanics 1* which was funded by the Nuffield Foundation and published by Longman in 1994 (ISBN 0-582-09979-X).

The PowerPoint demonstration with the same name can be used to aid class discussion.

The first six slides include the main points from Page 1 – whilst discussing these you can add more advice about carrying out the activity if you think this is necessary.

The last two slides are intended to be used after students have completed the activity to aid class discussion of the main points given in the summary on Page 2.

Possible Extension

If you can provide a number of blocks made of different materials and a number of different horizontal surfaces, students could also be asked to carry out experiments to find estimates for the value of m for different combinations of surfaces. It would be useful to use blocks that have the same mass, perhaps 1 kilogram.

