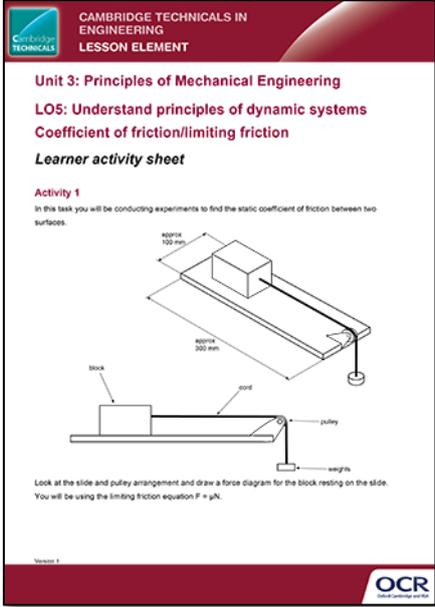# Unit 3: Principles of Mechanical Engineering

LO5: Understand principles of dynamic systems

Coefficient of friction/limiting friction

Instructions and answers for teachers

These instructions should accompany the OCR resource 'Understand principles of dynamic systems – Coefficient of friction/limiting friction' activity which supports Cambridge Technicals in Engineering Level 3.

The Activity:

This Lesson Element gives learners the opportunity to explore the friction acting between two surfaces, and the factors that influence the maximum friction force.

This activity offers an opportunity for English skills development.

This activity offers an opportunity for maths skills development.

Suggested timings:

Activity 1 30 minutes

Activity 2 45 minutes

Activity 3 1 hour

Activity 4 45 minutes

Associated materials:

Equipment needed is shown in the images below. Any suitable materials can be used to make the slide or block and the dimensions are approximate. In addition to this simple slide and pulley arrangement you will need standard laboratory weights (for example http://www.fisher.co.uk/1/1/149398-mass-hanger-small-form-cast-alloy-50g.html), a length of cord and small samples of test materials.
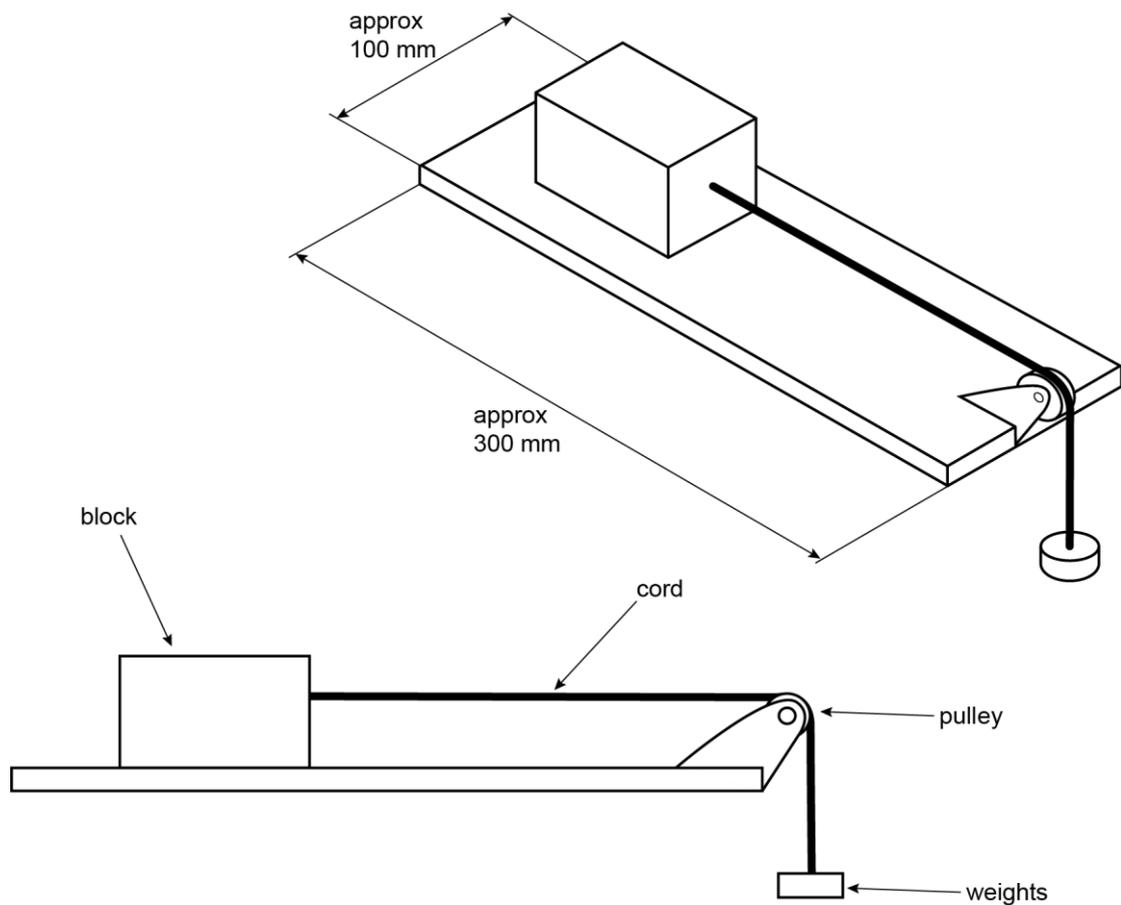
Activity 1

The experiment is simple. A block, of known mass is placed on the board and is connected to weights by the cord which passing over the pulley. Weights are slowly added until the block just begins to move, thus creating limiting friction.

It might be useful to discuss the factors that might influence the outcome of the experiment. For example, the area of materials in contact, the change in tension in the cord as it passes over the pulley, the angle the cord makes with the surface of the slide.

It is important that the weights are added as slowly as possible to avoid 'jerking' the block into motion - alternatively the block can be held until the weight is applied and then released to see if limiting friction has been reached.

You should arrange for the materials to be prepared (as per the drawing below) so that they can be presented to the learners.

In this activity, learners are asked to draw a force diagram for the block resting on the slide. They should use the limiting friction equation F = μN.

Activity 2

By adding weights to the block the effect of increasing the normal contact force between the two friction surfaces can be found. Learners should be asked to plot a graph of normal force against the tension in the cord (i.e. the weight needed to create movement). This should produce a linear graph with a gradient (Tension (friction force) on y axis and Weight of the block (Normal force) on x axis) equal to the coefficient of friction between the block and the slide.

Activity 3

By temporarily attaching different materials to the two contact surfaces it is possible to explore the range of values for the coefficient of friction.

It is important that the cord between the block and the pulley should remain as close to horizontal as possible so that adding weights will not affect the normal contact force between the block and the slide. If the dimensions of the samples of material for test make this unachievable it will be necessary to measure the angle of the cord to the slope and calculate the components of the tension on the string acting on the block.

Activity 4

This experiment can be extended by placing the slide at an angle to the horizontal, creating an inclined plane.

Learners will need to resolve forces perpendicular and parallel to the slope before applying the equation for limiting friction.

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