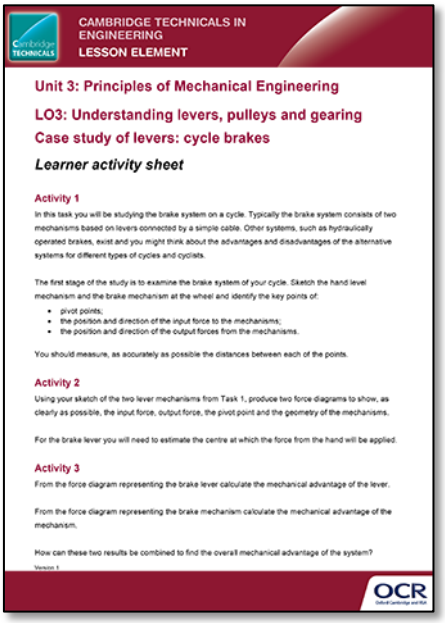
Unit 3: Principles of Mechanical Engineering

LO3: Understanding levers, pulleys and gearing

Case study of levers: cycle brakes

Instructions and answers for teachers

These instructions should accompany the OCR resource 'Understanding levers, pulleys and gearing – Case study of levers: cycle brakes' *activity which supports Cambridge Technicals in Engineering Level 3.*


CAMBRIDGE TECHNICALS IN ENGINEERING
LESSON ELEMENT

Unit 3: Principles of Mechanical Engineering

LO3: Understanding levers, pulleys and gearing

Case study of levers: cycle brakes

Learner activity sheet

Activity 1

In this task you will be studying the brake system on a cycle. Typically the brake system consists of two mechanisms based on levers connected by a simple cable. Other systems, such as hydraulically operated brakes, exist and you might think about the advantages and disadvantages of the alternative systems for different types of cycles and cyclists.

The first stage of the study is to examine the brake system of your cycle. Sketch the hand level mechanism and the brake mechanism at the wheel and identify the key points of:

- pivot points;
- the position and direction of the input force to the mechanisms;
- the position and direction of the output forces from the mechanisms.

You should measure, as accurately as possible the distances between each of the points.

Activity 2

Using your sketch of the two lever mechanisms from Task 1, produce two force diagrams to show, as clearly as possible, the input force, output force, the pivot point and the geometry of the mechanisms.

For the brake lever you will need to estimate the centre at which the force from the hand will be applied.

Activity 3

From the force diagram representing the brake lever calculate the mechanical advantage of the lever.

From the force diagram representing the brake mechanism calculate the mechanical advantage of the mechanism.

How can these two results be combined to find the overall mechanical advantage of the system?

The Activity:

The aim of this lesson is to encourage learners to apply the theoretical knowledge of the unit to practical situations. It is a study of cycle brakes which, commonly, consist of two lever mechanisms connected by a cable. (Hydraulic brakes sometimes found on cycles are beyond the scope of this unit.) There is an excellent review of different systems available from http://en.wikipedia.org/wiki/Bicycle_brake

Learners will be asked to examine and take relevant measurements from the braking system on a push bike consisting of the brake lever mounted on the handlebar of the cycle, and the brake mechanism that applies the brake block to the wheel rim. These will be used to calculate the mechanical advantage of the lever systems.

There are many opportunities for this activity to link to and reinforce other topics in this unit and other units in the qualification. Some of these will be identified within the following tasks.

This activity offers an opportunity for English skills development.

This activity offers an opportunity for maths skills development.

Suggested timings:

Activity 1 20 minutes

Activity 2 10 minutes

Activity 3 15 minutes

Activity 4 20 minutes

Activity 1

Learners should have access to one or more cycles fitted with cable operated brakes. They should be asked to make sketches of the mechanisms of the brake system (either front or rear brake) and take accurate measurements of relevant components. Some discussion and guidance may be needed to identify the dimensions that will be needed to carry out subsequent calculations.

It might be helpful if more than one design of brake were available for learners to examine so that they would be able to compare results for the mechanical advantage of different systems.

Activity 2

Learners should asked to produce clear force diagrams (Unit 3, LO1) to represents the brake lever and brake mechanism, clearly showing all pivot points (fulcrums), forces acting on the mechanisms and the distances between each of these. This may involve resolution of forces (Unit 1 - LO 4,Unit 3 - LO1).

Activity 3

From the force diagrams it should be possible to calculate the mechanical advantage of both the brake lever and the brake mechanism, and hence the total mechanical advantage of the system.

Activity 4

Learners might be asked to discuss how the result found in Activity 3 might be verified.

Depending on the measuring and test equipment available to learners it may be possible to verify this result, by direct measurement of forces. Alternatively measurement of the displacements of the point of application of input and output forces would allow the velocity ratio of the systems to be calculated. This inverse of this value will give the theoretical mechanical advantage of the system.

Learners might be asked why, in practice, the mechanical advantage of the system might be lower than the calculated value. Friction between the inner and outer cable connecting the brake lever and the brake mechanism will make the force acting on the brake mechanism lower than that leaving the brake lever. The friction between inner and outer cable can be reduced in several ways:

- use of materials with a low coefficient of friction;
- regular maintenance (lubrication);
- making cable runs as straight as possible (most friction will occur around bends in the cable);
- minimise the length of outer cable.

There is a possible link from this activity to work on friction between surfaces in Unit 3, L05.

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