FACTFILE:

GCE TECHNOLOGY & DESIGN

1.21 Pneumatic and Mechanical Components

Rewarding Learning

Mechanical Levers and Linkages

Learning outcomes

Students should be able to:

- demonstrate knowledge and understanding of:
  - first, second and third class levers,
  - linkages: bell crank and parallel.

Course Content

Levers

A lever is a rod that pivots about a fixed axis called a fulcrum.

Fig 1

Levers can produce a small output motion by applying a large input motion. The large input motion often requires a small effort; however, depending on the length of the lever, the load that is moved can be significantly greater.
E.g. The handbrake lever on a car requires a large movement to move the brake cable a short distance.

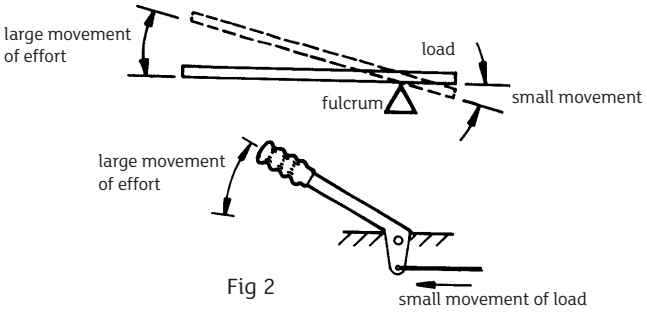


Fig 2

Types of lever

There are three classes of lever. Each class has the fulcrum, load and effort arranged in different ways as shown below:

Examples of the three levels are:

Class 1 - a see saw or set of scales

Class 2 - a wheelbarrow or nut cracker

Class 3 - a pain of tweezers or a fish caught by an angler

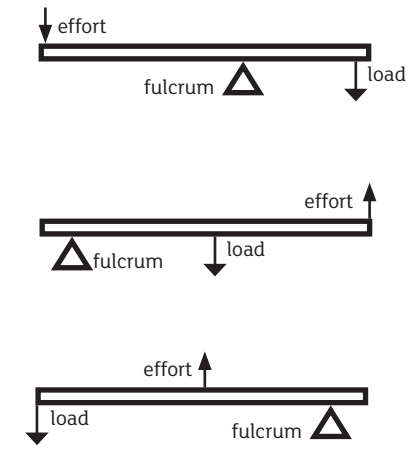


Fig 3

A simple method of remembering the classes of lever is by quoting the following:

F L E
1 2 3

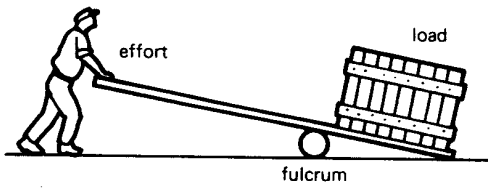
The numbers on the bottom line relate to the class of lever and the F, L and E relate to fulcrum, load and effort being the middle component or force in that class of lever. For Class 1, the fulcrum is the object in the centre of the arrangement. For Class 2, the load is the force in the centre of the arrangement. Finally, for Class 3, the effort is the force in the centre of the arrangement.

Velocity ratio
The ratio of the amount of movement made by the effort to the amount of movement made by the load is called the **Velocity Ratio.**

$$\text{Velocity ratio} = \frac{\text{Distance moved by the effort}}{\text{Distance moved by the load}}$$

By positioning the fulcrum in suitable place, the lever can be used so that a small effort can lift a large load. The ratio of the load and effort forces is called the **Mechanical Advantage** of the lever.

$$\text{Mechanical advantage} = \frac{\text{Load}}{\text{Effort}}$$



The positioning of the load, effort and fulcrum system is important. A small effort can move a larger load so creating a mechanical advantage.

In a case such as this the small effort will be able to move a larger load but will itself have to move a larger distance than the load will move. E.g. when using a wheelbarrow a large load can be lifted by a smaller effort but the effort must move a greater distance than the load.

Bell Crank:
The bell crank allows input motion to be transmitted through a right angle to give an output motion.

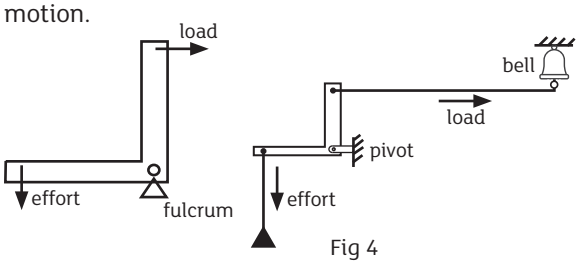


Fig 4

Another type of a bell crank can be used for bicycle brake systems. The long levers at each side of the wheel are hinged at the bottom and attached to the bicycle forks. They house a brake pad that can be positioned at each side of the wheel rim.

When the cyclist pulls the brake lever that is attached to the handle bars, the brake cable pulls the two levers together and press the brake pads against the wheel rim, slowing it down.

A double version of the bell crank can be seen

Fig 5

below. It this case the effort force can be used to move two loads.

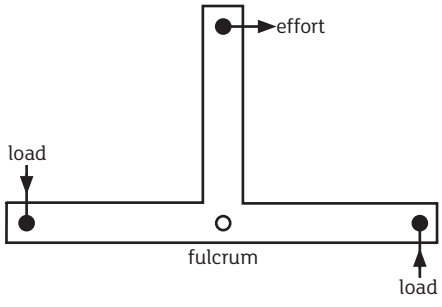
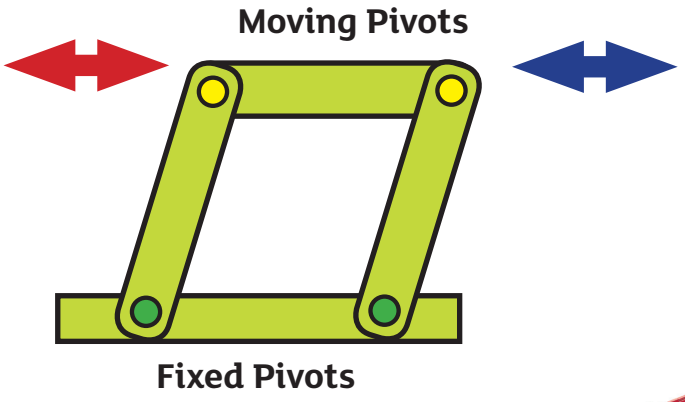
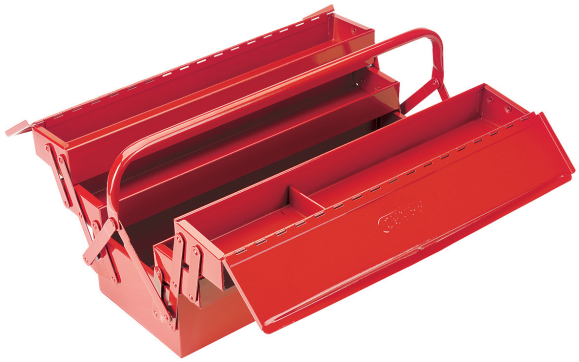


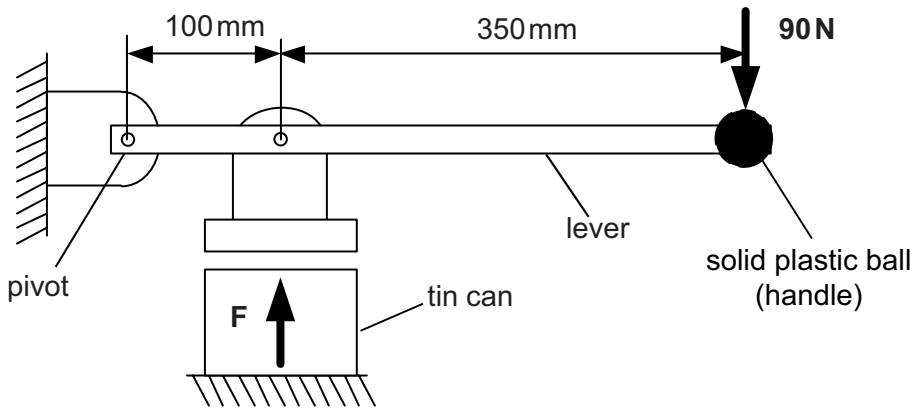
Fig 6 Parallel Linkage



In a parallel linkage motion can be transferred from one location to another. This is used in a variety of devices such as a traditional tool box where the two halves of the lid open out and remain more or less parallel at all times.



1. The figure below shows a lever used to crush tin cans.



(i) What class of lever is used in the tin can crusher?

_____ [1]

(ii) Calculate the force **F** when a force of 90 N is applied to the handle.

Answer _____ [4]