

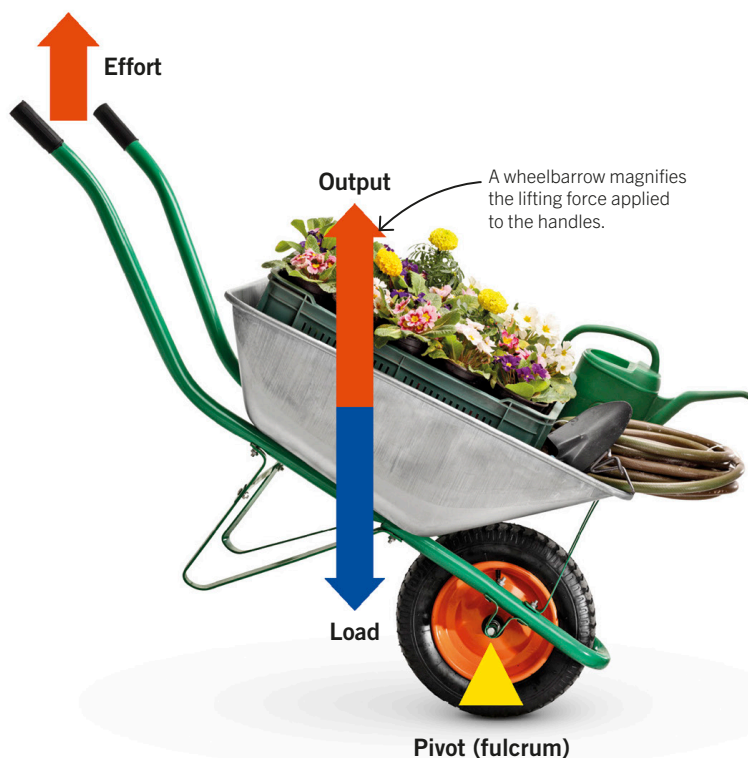


Levers

Levers are simple machines that magnify or reduce the effects of forces. We use them all the time, often without realizing. Scissors, wheelbarrows, door handles, and even our arms and legs work as levers.

How levers work

A wheelbarrow acts as a lever to make lifting easier. Like all levers, it rotates around a point called a pivot (or fulcrum), which in this case is the wheel. When a force (called the effort) is applied at the handles to lift the wheelbarrow, it is magnified to create a larger output force that overcomes the load in the barrow. The farther the effort is from the load, the greater the force is magnified.



Key facts

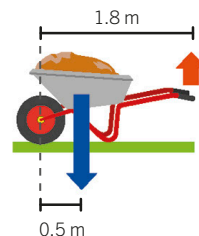
- ✓ A lever is a rigid object that can rotate around a fixed point called a pivot or a fulcrum.
- ✓ Levers can magnify or reduce the effect of a force.
- ✓ Levers that magnify a force reduce the distance traveled by the load.
- ✓ Levers that reduce a force increase the distance traveled by the load.



Calculating effort

Question

A wheelbarrow is filled with soil weighing 450 N and with a center of mass 0.5 m from the wheel. If the handles are 1.8 m from the wheel, what is the effort needed to lift the soil?



Answer

First, use the equation for moments (see page 84) to calculate the moment due to the load.

$$\begin{aligned}\text{moment (Nm)} &= \text{force (N)} \times \text{distance (m)} \\ &= 450 \text{ N} \times 0.5 \text{ m} \\ &= 225 \text{ Nm}\end{aligned}$$

Next, calculate the force needed to produce a moment of the same size when applied at the handles. Rearrange the equation to make force the subject.

$$\begin{aligned}F &= \frac{M}{d} \\ &= \frac{225 \text{ Nm}}{1.8 \text{ m}} \\ &= 125 \text{ N}\end{aligned}$$



Lever classes

Levers come in three different classes, depending on where the effort, load, and pivot are in relation to each other. If the effort is farther from the pivot than the load, the lever magnifies the force. If the effort is nearer, the lever reduces the force but increases the distance moved.

Class 1 Lever	Class 2 Lever	Class 3 Lever
<p>In class 1 levers, the pivot is between the effort and load. Class 1 levers can magnify or reduce forces. Pliers magnify forces to grip small objects tightly.</p>	<p>In class 2 levers, the load is between the pivot and the effort. These levers magnify the force you put in. Nutcrackers, for example, make it easier to crack nuts.</p>	<p>In class 3 levers, the effort is between the pivot and the load. Tweezers and other class 3 levers reduce the force you put in, making it easier to handle delicate objects.</p>

Machines

Mechanical devices that magnify or reduce forces (or that change the direction of forces) are known as machines. Simple machines such as levers often form parts of more complex machines with several moving parts. Here, a lever is connected via a gear to a toothed bar that moves down when the lever swings, magnifying the force from the user to squeeze oranges.

