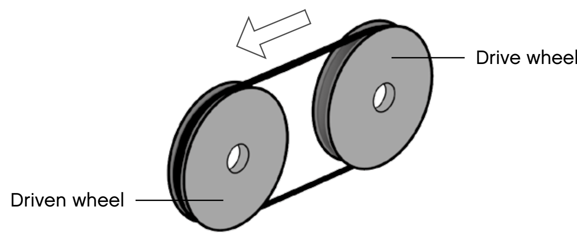
Pulley

Student Worksheet

Simple Machines: Pulley

Pulleys are wheels that are moved by ropes, chains or belts around their rims.

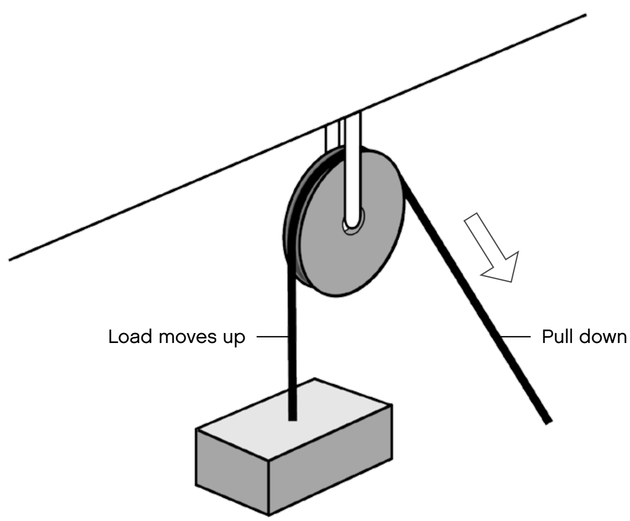


In a belt driven pulley a continuous belt joins two pulley wheels. The wheel to which an external force is applied (effort) is called the drive wheel, and the other the driven wheel. The drive pulley wheel provides the input force and the driven pulley wheel delivers the output force. When the drive wheel turns the belt moves and causes the driven wheel to turn in the same direction. If the drive wheel is smaller than the driven wheel, the driven wheel will turn more slowly than the drive wheel.

Belt driven pulleys rely on belt friction to transmit motion. If the belt is too tight the belt will create wasteful friction forces on the pulley axle and bearing. If too loose the belt will slip and the effort is not used efficiently. Slip is an overload protection safety feature of belt-operated machinery.

For heavy lifting jobs; multiple pulley wheels can be combined into a lifting system that makes lifting heavy objects easier.

Did you know?
Pulleys started the age of mass production in England, when they were produced at the beginning of the 19th century to supply the British Royal Navy with pulley blocks for their war ships during the Napoleonic Wars.



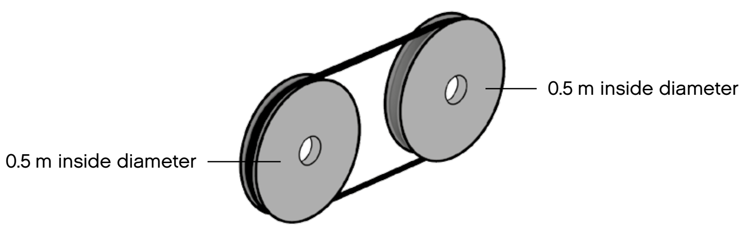
Using a single pulley to lift a load doesn't make it easier, but it changes the direction of motion without any gains in speed or required effort. It only allows you to lift a load up by the pulling of the rope. Pulleys can be either movable or fixed. The difference between fixed and movable pulleys are that fixed pulleys do not move up or down when the load is being moved.
A fixed pulley is often fixed to an overhead beam or rafter and will only be able to rotate around its own axle. The use of multiple pulley wheels on one axle, in a lifting or dragging system, is called a Block and Tackle.

Common examples of pulleys are found in window blinds, curtains and flagpoles.

The mechanical advantage of a pulley

The advantage of a pulley lies in the trade-off between force and distance. In general, what you gain in useful force, you have to make up by traveling extra distance. The most accurate way of calculating the mechanical advantage of a belt driven pulley is to divide the inside diameter of the driven pulley wheel by the inside diameter of the drive pulley wheel. You can also compare the number of rotations of the driven pulley wheel to one rotation of the drive pulley wheel. However slip may affect the accuracy of your comparison.

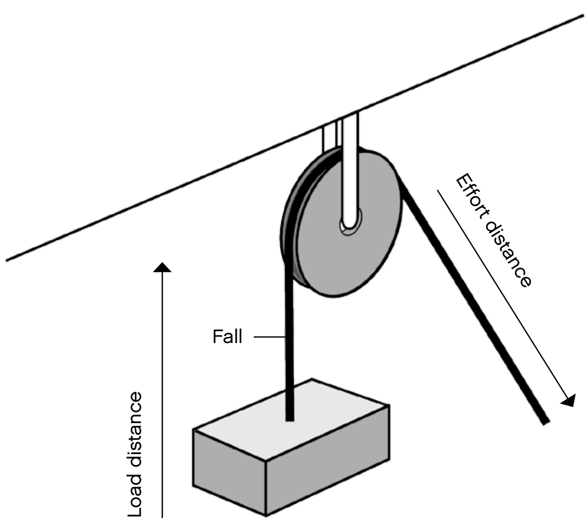
$$\textbf{Mechanical advantage} = \frac{\textbf{Driven pulley diameter}}{\textbf{Driver pulley diameter}}$$



$$\textbf{Mechanical advantage} = \frac{\textbf{0.5 m}}{\textbf{0.5 m}}$$

$$\textbf{Mechanical advantage} = \textbf{1}$$

There are two ways of determining the mechanical advantage of a pulley system. The simplest way to determine the mechanical advantage is counting the number of falls (or active lifting ropes) that are actually attached to the load. Alternatively, you can divide the effort distance by the load distance.



Mechanical advantage = 1

Hint:

The inside diameter of a large pulley wheel is 22 mm (≈ 0.8 in).

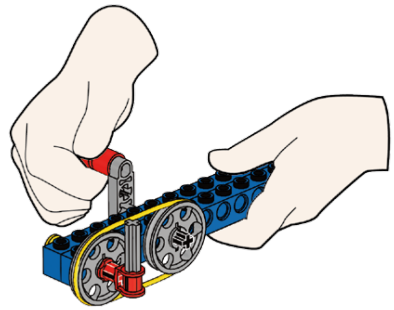
The inside diameter of a small pulley wheel is 5.8 mm (≈ 0.22 in).

Did you know?
In theory, you should be able to lift any object regardless of its weight using a huge block and tackle system and huge lengths of rope. However, due to an increase in friction, the system will eventually become inefficient to the point where it gives no mechanical advantage.

C1

Build C1 book I, page 18

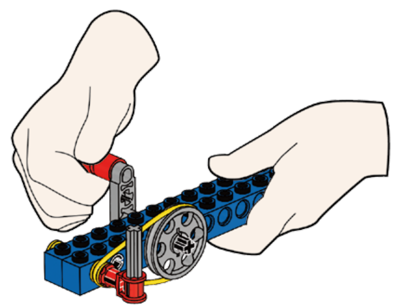
Calculate the mechanical advantage. Then turn the handle while gently increasing your grip on the output pointer and explain what happens and why.



C2

Build C2 book I, page 19

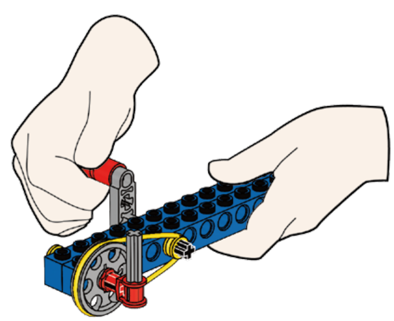
Calculate the mechanical advantage. Then turn the handle while gently increasing your grip on the output pointer and explain what happens and why.



C3

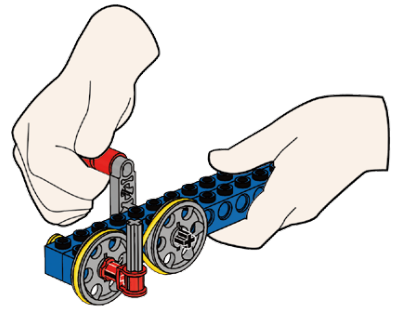
Build C3 book I, page 20

Calculate the mechanical advantage. Then turn the handle while gently increasing your grip on the output pointer and explain what happens and why.



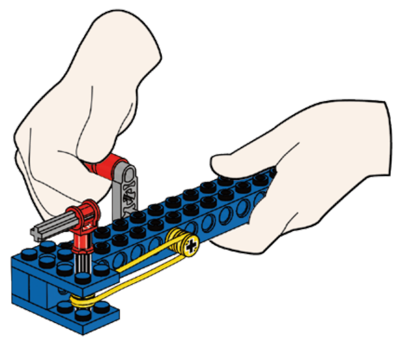
C4

Build C4 book I, page 21
Calculate the mechanical advantage. Then turn the handle while gently increasing your grip on the output pointer and explain what happens and why.



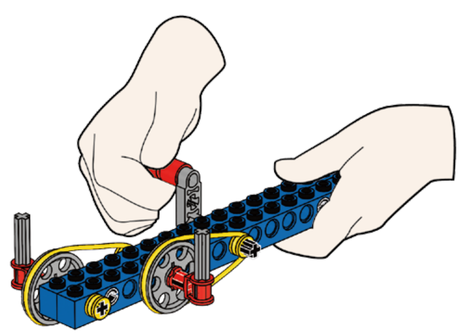
C5

Build C5 book I, pages 22 to 23
Calculate the mechanical advantage. Then turn the handle and explain what happens and why.



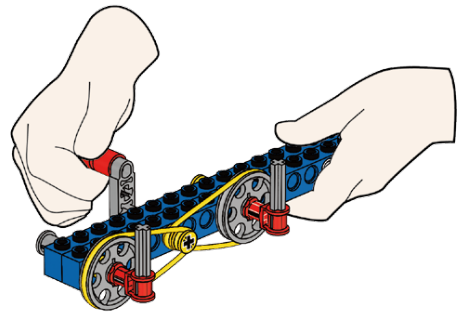
C6

Build C6 book I, pages 24 to 25
Calculate the mechanical advantage. Then turn the handle and explain what happens and why.



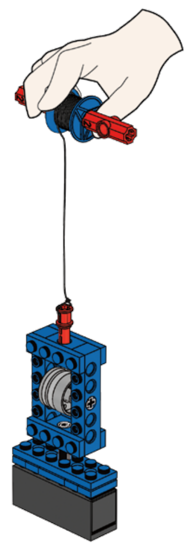
C7

Build C7 book I, pages 26 to 27
Calculate the mechanical advantage. Then turn the handle and explain what happens and why.



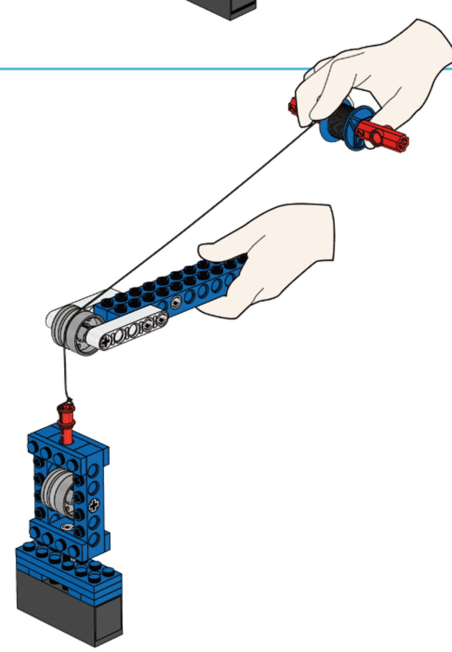
C8

Build C8 book I, pages 28 to 31
Lift the string to lift the load. Describe what happens.



C9

Build C9 book I, pages 32 to 35
Calculate the mechanical advantage. Then pull the string to lift the load. Explain what happens and why.



C10

Build C10 book I, page 36
Calculate the mechanical advantage. Then pull the string to lift the load. Explain what happens and why.