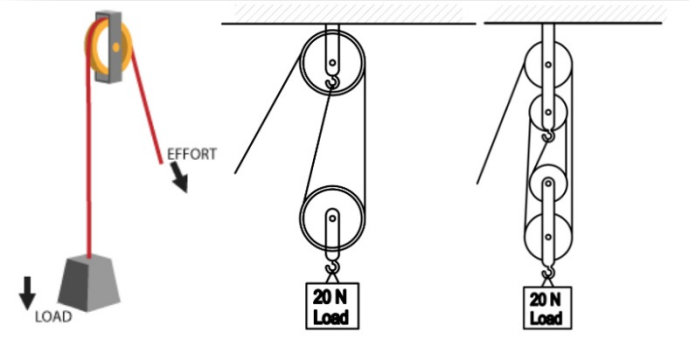
Mechanisms – for lifting

Pulley system

The simplest pulley systems used for lifting a load use only **one pulley**. This allows the load to be lifted up by pulling down. It is much easier and safer to be on the ground pulling down rather than pulling a load up from above. In theory, to raise the load, your effort force has to be equal to or just greater than the load. There is no mechanical advantage. In practice, with a heavy load, your effort has to be quite a bit more than the load in order to overcome friction.



By using more than one pulley you can create a mechanical advantage. The more pulleys you use, the greater that advantage is. Diagram shows a pulley system with a mechanical advantage of 2:1. It allows a load to be raised using only half the effort needed using a single pulley, but twice as much rope must be pulled in.

For the second pulley system with twice as many pulleys the mechanical advantage is 4:1.

Note that you can work out the mechanical advantage simply by counting the number of ropes passing between the top and bottom sets of pulleys. As more pulleys are used, less effort is needed to raise the load, but much more rope has to be pulled in.

Yachts and other sailing vessels make great use of these kinds of pulley systems to cope with the large forces involved in controlling large sails.

Calculate Velocity Ratio in a lifting system

The ratio of the speed at which the load moves compared to the speed at which the effort moves can be calculated using the formula:

Velocity Ratio = distance moved by the effort distance moved by load.

When a pulley system is used to raise a load upwards the effort required is less due to the mechanical advantage, but the distance you have to pull the rope increases in proportion. In other words, if you raise a 1 meter 200N load with a pulley with a mechanical advantage of 2:1, the effort required would be a 100N but you would have to pull the rope 2 meters. The speed at which the load moves is half that of the effort. (The load raises half the distance the effort travels)

The velocity ratio or VR, assuming 100% Load efficiency, will always be equal to the mechanical advantage MA.