## Pulley Power!

## What is a Pulley?

A pulley is a grooved wheel on an axle. Around the wheel runs a rope, cable, belt or chain. Two or more pulleys together are called a block-and-tackle. Pulleys are used to change the direction of a force or to obtain a mechanical advantage (that is, they make our work easier!). Pulleys date back at least to Archimedes (287 BC-212 BC), the great Greek mathematician, physicist, and engineer. He designed a block-and-tackle system to move massive ships.


## Pulley Systems

Pulley systems allow us to lift a load by using a force that is less than the weight of the load. To lift a load a given height, however, we must pull the free end of the rope a greater distance. (The pulley is a type of simple machine; others are the lever, inclined plane, wedge, screw.)


## Compound Pulleys

A compound pulley system combines a fixed (not moving) pulley with a movable pulley (attached to the load). The mechanical advantage can be greater than with only fixed pulleys.

Left: Block-and-tackle pulley system

Right: Archimedes pulley system


## Building Pulley Systems

Using pulleys and string, try building your own pulley system. See if you can lift a heavy load.
How is the number of pulleys related to the distance you must pull and force you must exert?
$\square$

| Number of <br> Pulleys (N) | Height that Load <br> is Lifted (H) | Length of Rope <br> Pulled (L) | $\mathrm{N} \times \mathrm{H}$ | Force (F) |
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For simple block-and-tackle systems, the number of ropes supporting the load is equal to the number of pulleys. The mechanical advantage is then just equal to the number of pulleys.
For compound pulley systems, the mechanical advantage can increase exponentially with the number of pulleys! In practice, friction between ropes and wheels limits the number of pulleys.

In all pulley systems, the applied force F decreases inversely with the distance D that the free end of the rope must be pulled. In physics, we define the work done as "force times distance" $(\mathrm{W}=\mathrm{FxD})$. Then the work done to lift a load a given height is exactly the same for all systems!

