

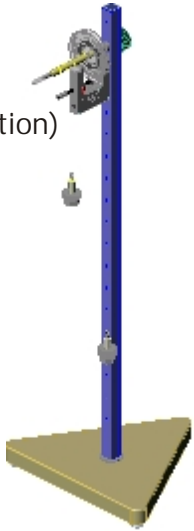
# Ultimate Pulleys with Springs

## Assembly Instructions

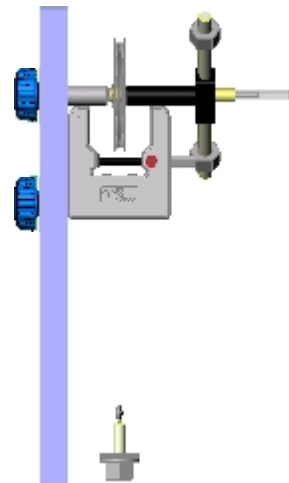
The Ultimate Pulleys set is a versatile, robust module that allows students to investigate multiple concepts: force, mass, acceleration, rotational motion, torque, work, energy, conservation of momentum, and mechanical advantage. These instructions present the basic steps for setting up the Ultimate Pulleys for the different activities.

### Ultimate Pulleys

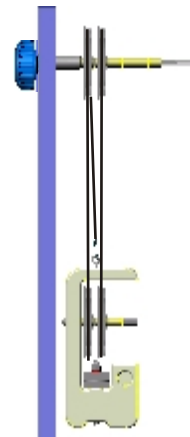
Atwood's Machine  
(force, mass & acceleration)



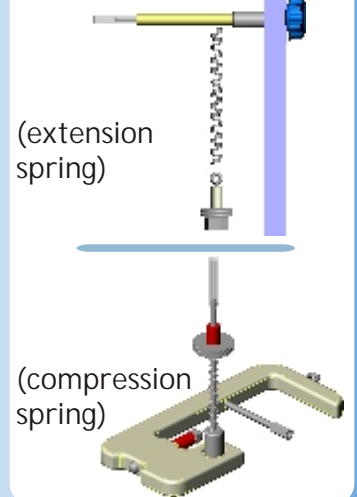
Moment of Inertia & Torque



Mechanical Advantage  
(ropes & pulleys, block & tackle)

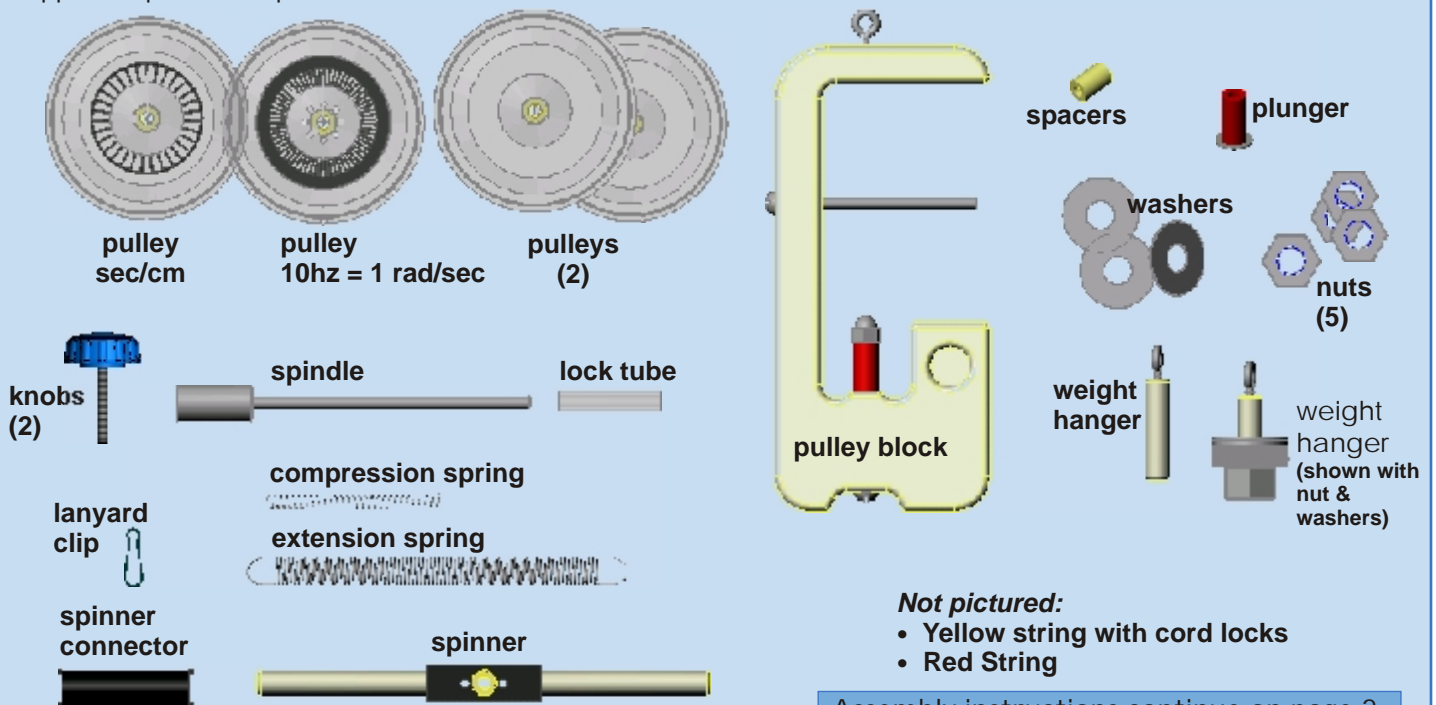


Hooke's Law



### Ultimate Pulleys Components

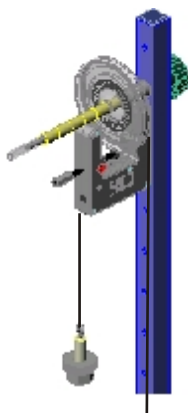
Below are the components of the Ultimate Pulleys set. Included are multiples of some of the items like the washers, spacers, nuts and lanyard clips. These are necessary to perform the entire range of activities. In addition we have supplied replacement parts for some of the items.



Assembly instructions continue on page 2.

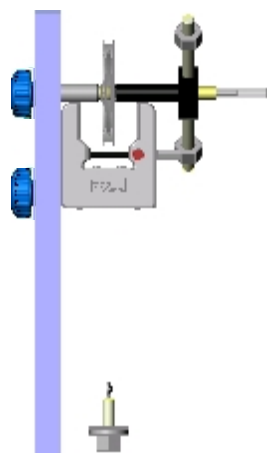
## Atwood's Machine Setup

1. Attach the spindle to the top hole using a threaded knob.
2. Find the pulley that is labeled "sec/cm." Slide the pulley onto the spindle. Use plastic spacers and the lock tube to keep the pulley from sliding off the spindle.
3. Attach the threaded plastic hangers to the string. Place 5-10 washers onto one of the hangers. Put a greater number of washers onto the second hanger.
4. Loop the string over the pulley so that the first hanger (with less mass) is sitting on the base of the stand. When you release the second hanger, the first will rise as the second one falls.
5. Changing the washers allows you to change the mass and/or force acting on the system.



## Moment of Inertia Setup

1. Attach the spindle to the top hole using a threaded knob.
2. Slide the pulley marked "10Hz = 1rad/sec" onto the spindle. Add the spinner connector and then add the spinner. The connector has teeth that engage with holes in the pulley on one end and the spinner at the other. Use a plastic spacer and lock tube to hold everything on the spindle.

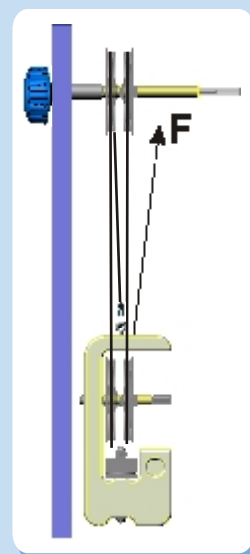


3. Add a nut to each end of the spinner. Adjust their position so that the spinner balances horizontally.
4. Attach 5 washers and a nut to one hanger. Attach the red string to the weight hanger with a lanyard clip. Hook the other end onto a notch in the rim of the pulley, and wind string around the pulley groove.

5. When the hanger is released, the pulley spins because the hanging mass creates a torque equal to its weight multiplied by the radius of the pulley.
6. Observe how the rod spins if you move the nut close to the center of the spinner compared with when the nuts are near the outside. In both cases, the spinner mass and the torque applied are the same. The *distribution* of the mass on the spinner is different.

## Mechanical Advantage Setup

1. Attach the spindle to the top hole using a threaded knob.
2. Slide a single pulley onto the spindle. Use plastic spacers and the lock tube to keep the pulley from sliding off the spindle.
3. Put 15 washers onto the wooden pulley block as shown in the diagram at right. Determine the weight of the loaded pulley block using a balance or spring scale. This is the output force since lifting the pulley block is the output task of the machine.
4. Attach the yellow string to the block with the lanyard clip and loop it over the pulley.
5. Measure the force required to hold up the pulley block by applying a downward force on the string on the opposite side of the pulley. This is the input force since it is the force applied to the machine to accomplish the output task (lifting the block).



6. The diagram at right shows a more complex setup using two pulleys on top and bottom. How does this affect the input force required to lift the loaded block?

## Other Configurations

Additional configurations investigate Hooke's Law by determining spring constants with compression and extension springs.

*For the instructions on the Hooke's Law activities and more details on any of the activities discussed in these instructions, please refer to our Foundations of Physics Investigations Guide or call us at the number below.*

For technical assistance,  
please call 866.588.6951.