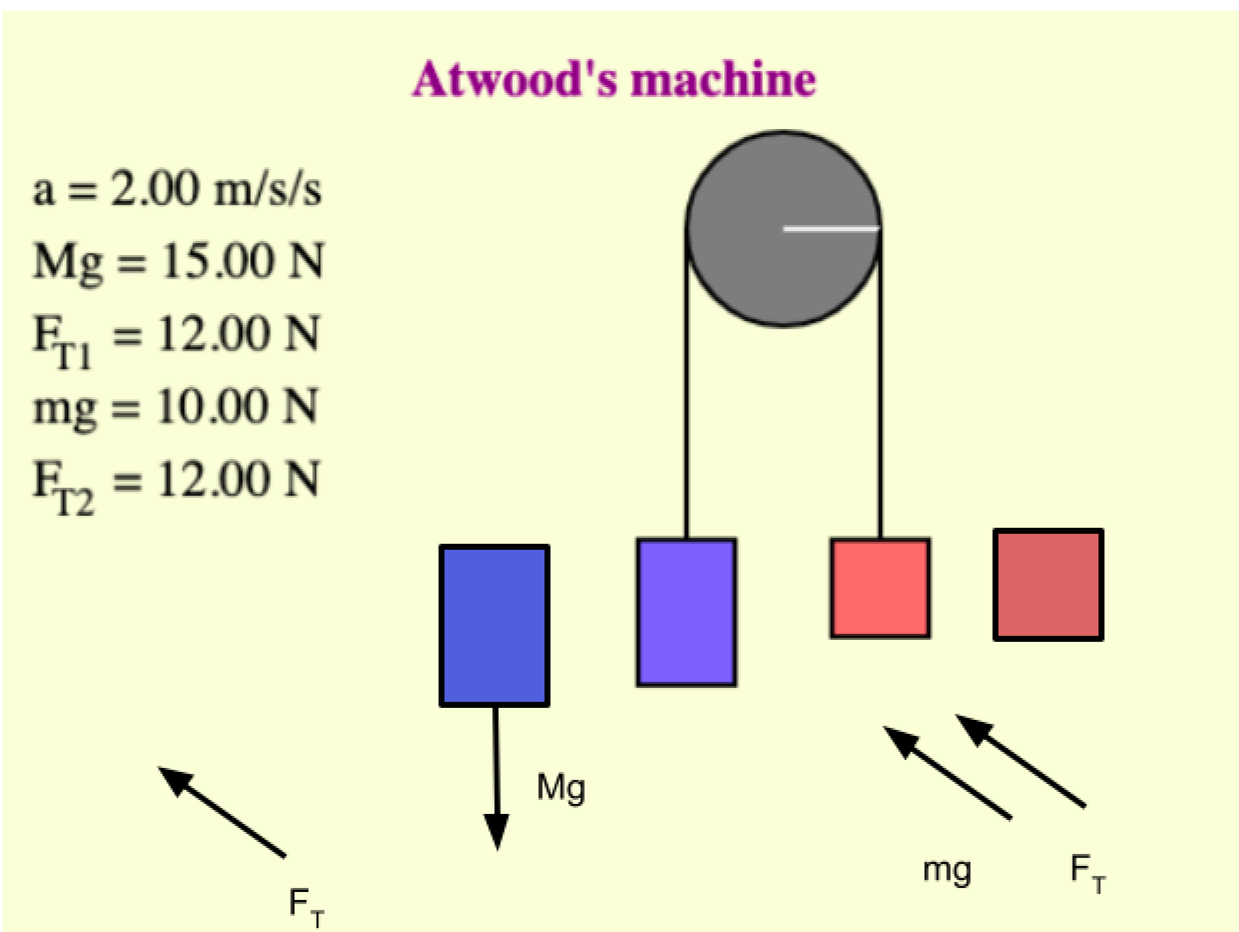
Use File > Make a copy to make your own copy of this worksheet, so that you can edit it.

Atwood's machine

Link to the [Atwood's machine simulation]

Play with the simulation for a couple of minutes, to explore what you can do with it.

Note that Atwood's machine is the name for a device consisting of two blocks, connected together by a string that passes over a pulley. This is shown below in the screenshot from the simulation. Note that, in this simulation, the mass of the pulley is negligible. The implication of this is that there is just a single tension in the string. The screen in the simulation shows two tension labels, but note that F_{T1} is always equal to F_{T2} in this situation. Also, note that the simulation uses g = 10.0 m/s^2.



1. Edit the diagram above and draw free-body diagrams for the two blocks. Use the blue block on the left to attach arrows to, and label the arrows (use arrows and labels at the bottom of the picture), to sketch the free-body diagram of the blue block. Use M to represent the mass of the blue block - it has a larger mass than the red block. Use the red block on the right to attach arrows to, and label the arrows (use arrows and labels at the bottom of the picture), to sketch the free-body diagram of the red block. Use m to represent the mass of the red block.

2. If this system is released from rest, the blue block will accelerate down and the red block will accelerate up, if the blue block has a larger mass than the red block. Thus, take down to be positive for the blue block, and up to be positive for the red block, so you can use “a” to represent the acceleration in both cases. Apply Newton’s second law to each free-body diagram and write out two force equations, one for each block.

3. Combine your two equations to eliminate the force of tension. Re-arrange the equation to solve for the acceleration, and verify that the acceleration matches the value shown in the screenshot above for the case when M = 1.5 kg and m = 1.0 kg.

4. Solve for the tension in the string and verify that your value matches the value shown in the screenshot.

5. Given the limits set by the sliders in the simulation, what are the most positive and most negative values that can be achieved for the acceleration of the blocks?

6. Describe how you can achieve an acceleration of +5.00 m/s^2 in the simulation. Note that this requires a specific ratio of M to m, so be sure to specify the M:m ratio in your response.

This worksheet was created by Andrew Duffy of Boston University on Jan. 8, 2023.