

Prep Instructions

A major step in the prep of this activity is choosing a good location. A key feature is an easily accessible top anchor. Some examples of good anchors are a solid tree branch (at least 20-30 cm in diameter) or an exposed structural beam in a laboratory, classroom or gymnasium. The anchor should be at least three metres above the ground and the surrounding area should be relatively flat and free of obstructions. Students will be able to lift themselves or their teacher a distance that is proportional to the height of the top anchor, thus a higher anchor will lead to a more impressive demonstration. However, setting up the pulley will be easier if the anchor is easy to reach with a ladder. Keeping these considerations in mind, a good height for the anchor would be between 3-5 m.

Before putting together the demonstration, all of the knots listed in *Additional Information* should be practiced so that they can be tied with ease. Test the strength of each knot and make sure they all match the pictures. Do not try to build the pulley system before being comfortable tying each knot.

Part I – Building the Swing

This part can be eliminated entirely if a swing base is purchased.

The following items will be required for the prep of this part of the activity:

- piece of plywood (approximately 1 ft. x 2 ft. x 1 in.)
- 2 pieces of 2 m long 7 mm static cord
- drill

Step 1

Drill a hole in each corner of the plywood board with a 8 mm (5/16 in.) bit about 5 cm from the edges. For reference, the holes have been labelled A through D (**Figure 1**). At this point, a top and bottom should be chosen for the seat. To thread a cord “up” through one of the holes, start on the bottom side of the seat and pass the rope through the hole to the top. Threading “down” is simply the same process but in the opposite direction.

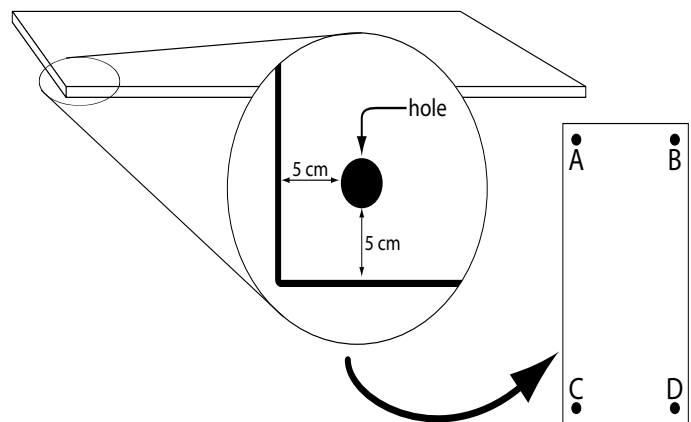


Figure 1

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Step 2

Tie a double fisherman's knot 10 cm from the end of one of the 2 m pieces of 7 mm cord (**Figure 2**). Thread the other end of the cord up through hole A in the plywood seat.

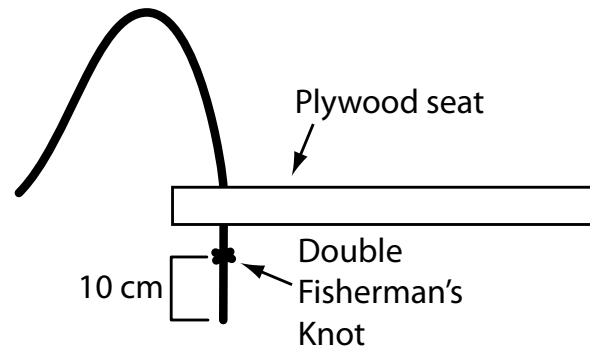


Figure 2

Step 3

Thread the free end of the cord from Step 2 down through hole B in the plywood and tie another double fisherman's knot below the seat (**Figure 3**).

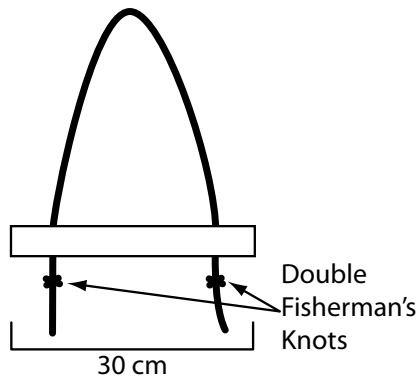


Figure 3

Step 4

Tie a double figure-eight loop in the middle of the cord making sure that the distance between the knot and each hole is the same (~70 cm) (**Figure 4**).

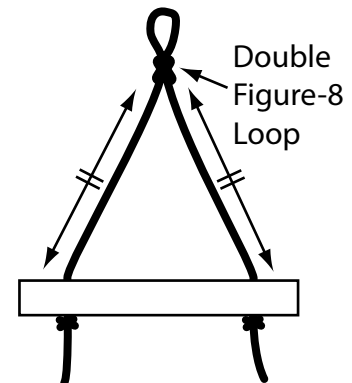


Figure 4

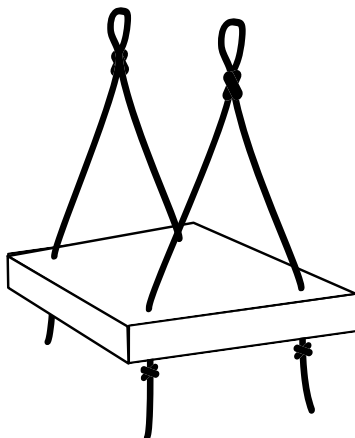


Figure 5

Step 5

Repeat Steps 2-4 with the other piece of 2 m long 7 mm cord and holes C and D. At this point, there should be a classic homemade swing (**Figure 5**). Next, the swing will be attached to the pulley system to demonstrate the mechanical advantage gained using pulleys.

Part II - Building the Bottom Pulley Apparatus

The following items will be required for the prep of this part of the activity:

- piece of scrap wood
- drill
- 1.2 m long piece of 7 mm static cord

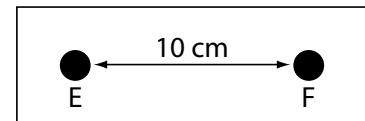


Figure 6

Step 1

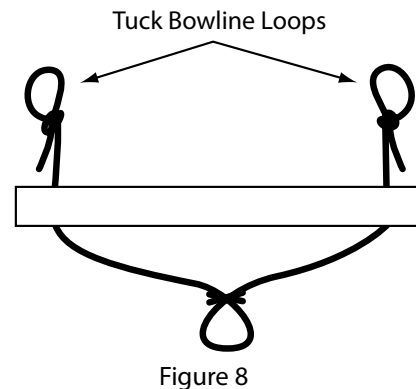
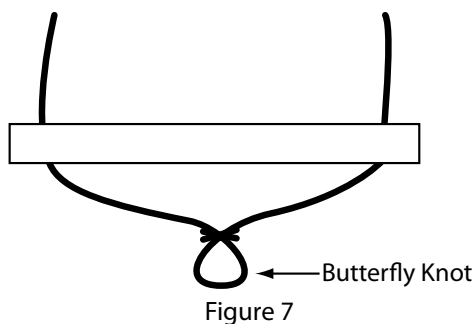
Drill a hole in both ends of the piece of scrap wood (about 10 cm apart) with an 8 mm drill bit (**Figure 6**). Once again, choose a top and bottom side for this piece of wood. This component will be used as a spacer between the two bottom pulleys so that the ropes do not rub, reducing the amount of friction.

Step 2

Tie a butterfly knot in the middle of the 1.2 m long piece of 7 mm cord (**Figure 7**). Try to get this knot close to the middle of the cord because this will make the next steps easier. Thread the ends of the cord upward into the two holes that were just drilled in the wood.

Step 3

Tie a tuck bowline loop in each end of the cord (**Figure 8**). These loops will attach to the two bottom pulleys. The butterfly knot will be attached to the swing from Part I.



Part III - Assembling the Pulley System

The following items will be required for the prep of this part of the activity:

- spacer with cord and knots (see Part II)
- 10 mm static cord
- 1 in. webbing
- 4 rock climbing pulleys
- 3 screw gate carabiners (quicklinks)
- 2 load-bearing carabiners

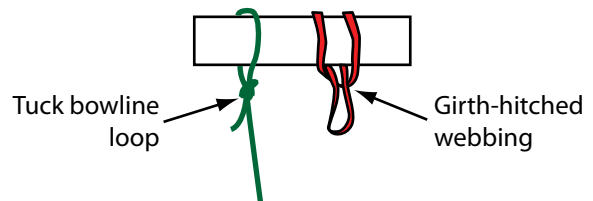
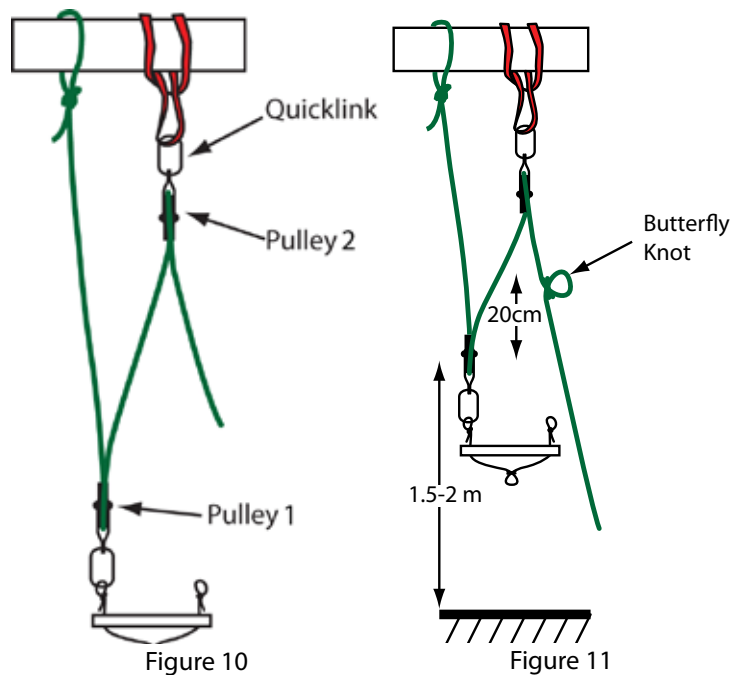


Figure 9

Step 1

Tie the webbing into a loop using a water knot and use a girth-hitch to attach it around the anchor. Tie one end of the 10 mm cord around the anchor next to the webbing using a tuck bowline loop (**Figure 9**). See *Additional Information* for step by step instructions of how to tie these knots around a beam.



Step 2

Attach the first pulley (pulley 1) to one of the bowline loops from Part II Step 3 and the second pulley (pulley 2) to the girth-hitched webbing using quicklinks (**Figure 10**). Be sure to screw the links closed. Thread the 10 mm cord through pulley 1 and back up to pulley 2.

Step 3

Pull the cord through the system until the bottom pulley is between 1.5 m and 2 m off the ground. This will be the maximum height of the pulley system. The displacement between the minimum height and this maximum will, however, be largest when the maximum is about halfway between the ground and the anchor. Tie a butterfly knot in the free end of the cord about 15-25 cm above the bottom pulley (**Figure 11**).

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Step 4

Using a carabiner, clip a pulley to the second bowline loop from Part II Step 3. Using a quicklink, attach a pulley to the butterfly knot that was just tied. Thread the cord through the bottom pulley and back up through the final pulley (**Figure 12**).

Step 5

Clip both loops of the swing to the butterfly knot between the two bottom pulleys with the second carabiner (**Figure 12**). The pulley is now ready to be used.

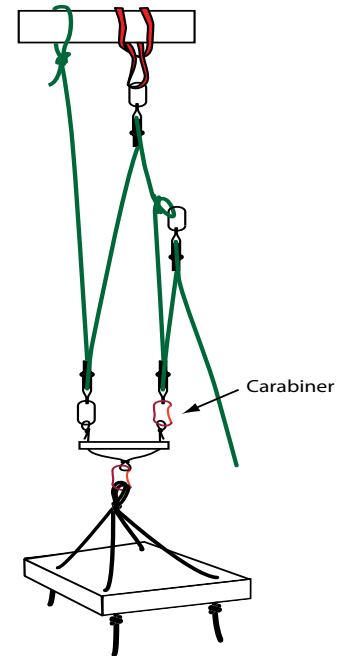


Figure 12