

AquaTrak User Guide

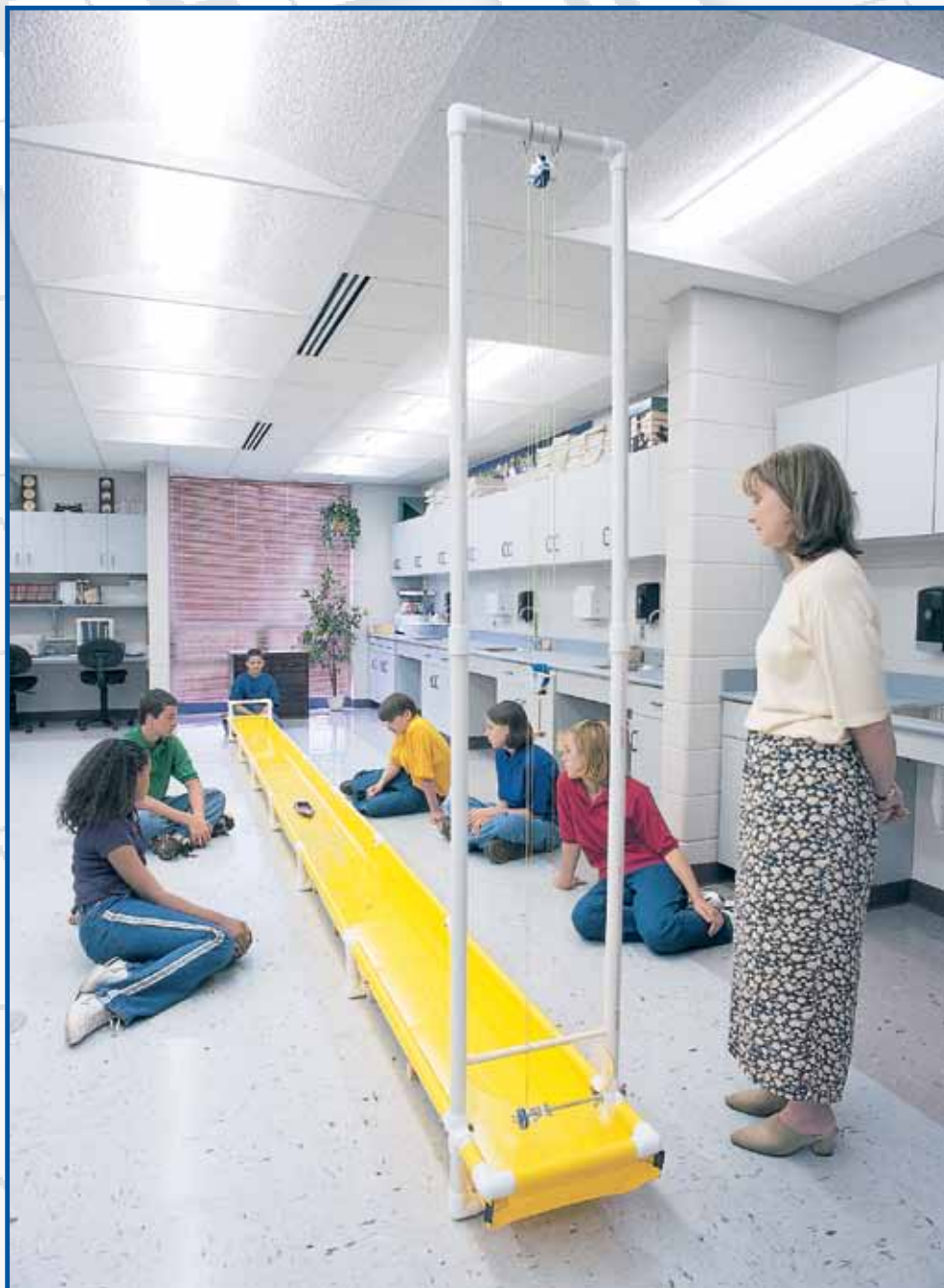


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Introduction to the AquaTrak

The AquaTrak is a six-meter boat track designed for testing boat hull designs and can also be used for timed racing. It gives students the opportunity to observe and practice concepts in science, technology, engineering, and math in a real-world setting, and it keeps them involved and excited from start to finish.

Students may use ready-made boats, trace patterns provided in books on boat design, or design and build their own boat hulls. Each completed boat is attached to the AquaTrak's simple pulley system, which pulls it smoothly through the water in a straight line.

With the AquaTrak, students can study the wake patterns of various hull designs, learn the effects of buoyancy and drag, and test and modify their boats to improve speed, stability, or load capacity.

Many of the hands-on aquatic activities made possible by the AquaTrak are natural extensions of concepts you might already teach, but for which you might have had little or no laboratory component – for example, buoyancy, density, and volume displacement.

Some activities will help you teach new concepts to expand your students' understanding of the interaction of water and watercraft, including hydrodynamic principles, propulsion, load, power, and efficiency. In whatever activities they do, students will learn and practice design, modeling, and problem-solving techniques.

The AquaTrak is great for hands-on math activities. Every boat activity that students do requires them to measure and calculate, giving them ongoing practice in the use of everyday math skills.

And the excitement generated by the AquaTrak will extend far beyond the science, math, or technology classroom. Our interdisciplinary curriculum package, *Boat Design and Testing: From AquaTrak to the Oceans* (included) will give you many ideas, both for using the AquaTrak and for incorporating boat projects into language arts, social studies, and other curriculum areas. So, dive into the water world by introducing your classroom to the possibilities of the AquaTrak!

AquaTrak Parts List

Before you begin assembling AquaTrak, make sure your kit contains all of the parts listed below. **Note:** In addition, your kit should include this manual; a copy of the AquaTrak curriculum, *Boat Design and Testing: From AquaTrak to the Oceans*; and a vinyl repair kit.

Part No.	Qty	Part Description	Part No.	Qty	Part Description
100	10	PVC U yoke sides with T connectors	112	18	10" wooden spacer blocks
101	4	PVC U yoke sides with four-way connectors	113	2	Flexible plastic splash guards
102	10	38" PVC pipes without holes	114	4	Binder clips
103	4	38" PVC pipes with 1/4" holes	115	3	Rubber plugs
104	2	38" PVC pipes with 5/8" holes	116	1	Lower line-guide pulley assembly (L-shaped)
105	11	12" PVC pipes	117	2	Pulley-block assemblies, one with hook attached
106	6	5" PVC pipes	118	2	Spring assemblies
107	2	PVC straight couplings	119	2	Brass weight sets
108	8	PVC 90° elbows	120	4	10-32 x 2" PHP machine screws
109	1	14-1/2" x 1/2" CPVC pipe	121	4	10-32 wing nuts
110	1	6-meter yellow vinyl tank	122	1	30' pulley line
111	6	10" x 38" wooden planks (for tank support)	123	1	Deadblow hammer
			124	2	7' lengths of fishing line (not shown)

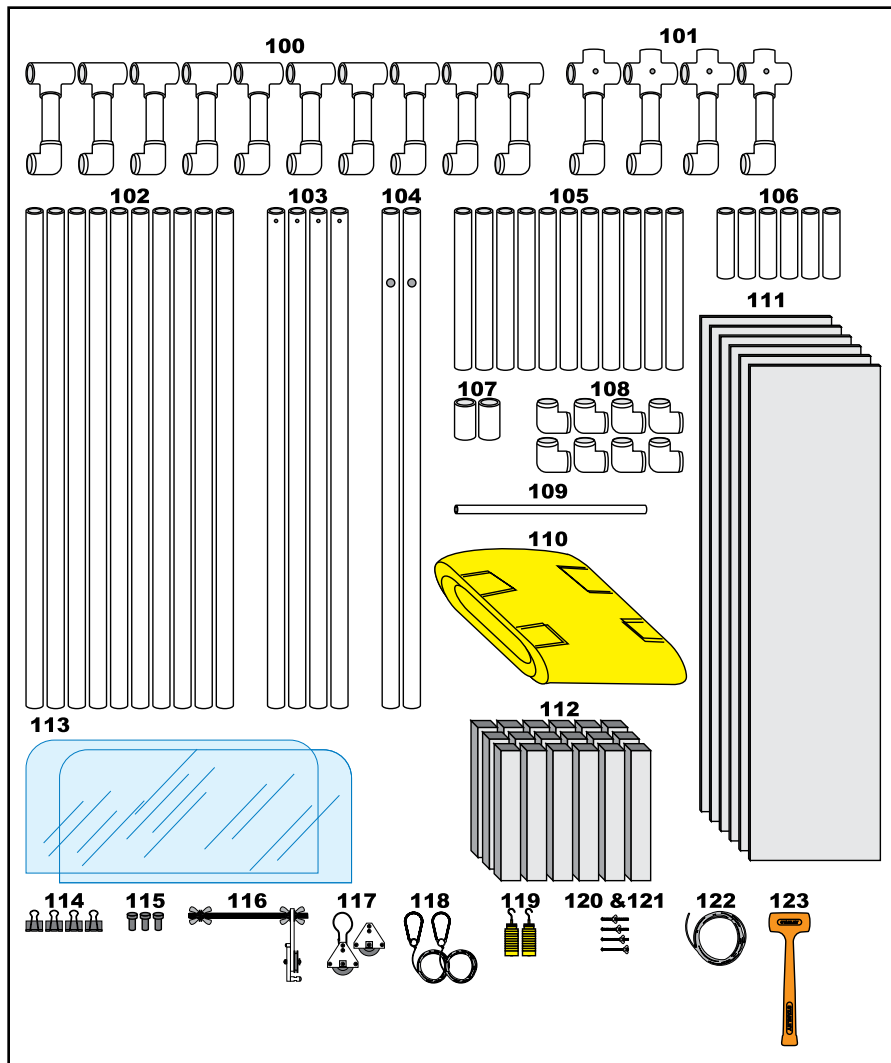


Figure 1

Tank Frame Assembly

The following parts are required to assemble the tank frame:

Part No.	Qty	Part Description
100	10	PVC U yoke sides with T connectors
101	4	PVC U yoke sides with four-way connectors
102	8	38" PVC pipes (tank side rails) without holes
103	4	38" PVC pipes (tank side rails) with 1/4" holes
105	10	12" PVC pipes
106	6	5" PVC pipes
108	6	PVC 90° elbows
110	1	6-meter yellow vinyl tank
111	6	10" x 38" wooden tank support planks
112	18	10" wooden spacer blocks
113	1	Flexible plastic splash guard
114	4	Binder clips
115	2	Rubber plugs
120	4	10-32 x 2" PHP machine screws
121	4	10-32 wing nuts
123	1	Deadblow hammer

Assemble the Tank Frame

1. Lay out all the parts in the above list.
2. Assemble the U yokes that will support the vinyl tank. Each yoke consists of two yoke sides (Part 100 or 101) connected by a 12" PVC pipe (Part 105). There will be two end yokes, using yoke sides with four-way connectors (Figure 2), and five center yokes, using sides with T connectors.

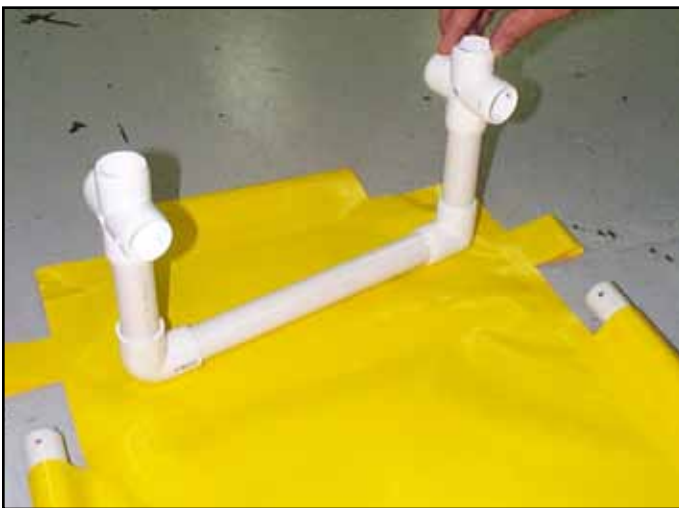


Figure 2

3. Unroll the vinyl tank (Part 110), lay it flat, and check that the AquaTrak logo is facing up.

4. Lay the assembled yokes in order (four-way yokes at ends, T yokes in center). They will be inserted under the tank at the openings in the tank sleeves.
5. Slide one of the end yokes (with four-way connectors) under the left end of the tank.

Note: Use the following directions to build the AquaTrak from left to right. Insert pairs of side rails first, followed by a center yoke. Seat each pair of rails firmly into the connectors before proceeding. Tap the rails gently with the deadblow hammer to ensure that they are completely seated. Otherwise, the tank lengths may be uneven on the two sides.

6. Slide two 38" side rails with 1/4" holes (Part 103) into the sleeves at the farthest left end of the tank, with the holes at the left end facing inward. Pull the sides up and slide the ends of the rails into the four-way connectors, matching the holes.
7. Insert a 10-32 x 2" PHP machine screw (Part 120) through each hole. Secure the screws on the outside with the wing nuts (Part 121) (Figure 3).



Figure 3

8. Slide a U yoke with T connectors under the tank at the right end of the first pair of rails. Insert the right ends of the rails into the left ends of the T connectors (Figure 4).



Figure 4

9. Work your way down to the right end of the tank, inserting four pairs of rails without holes (Part 102) into tank sleeves and connecting them to the center yokes (with T connectors) (Figure 5).



Figure 5

10. Insert the last pair of rails with 1/4" holes (Part 103) into the farthest-right pair of tank sleeves so that the holes are at the right end of the tank, facing in toward the tank. Fit each rail into the corresponding four-way connector on the U yoke and secure with 10-32 x 2" screws and wing nuts as in Step 6.
11. Put the ends of the tank together. (Instructions are the same for both ends.)
 - a. Slide two 5" PVC pipes (Part 106) through the short sleeves at the end of the tank and into the open horizontal ends of the four-way connectors.
 - b. Slide a 12" PVC pipe (Part 105) through the sleeve on the end of the tank.
 - c. Connect the 12" pipe with the two 5" pipes by placing elbow couplings (Part 108) on each end (Figure 6).

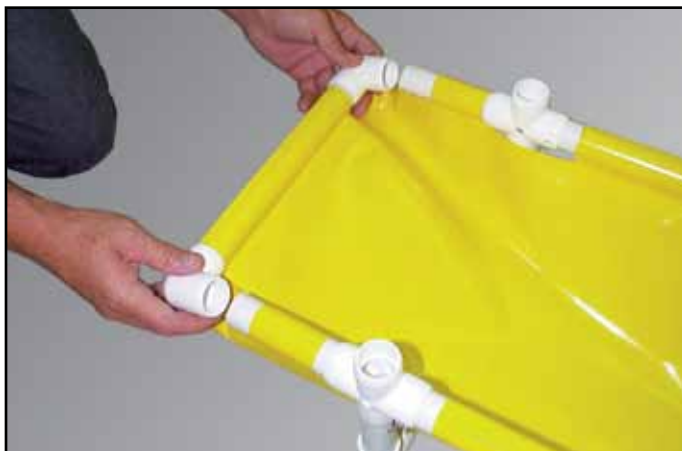


Figure 6

- d. Pull up the edges of the vinyl tank at the two corners, fold over once, and clip with a binder clip (Part 114) to square the corner.

Note: At this point, you must decide which direction you want the boats to travel and designate a start end and a finish end. Step 12 explains how to assemble the start end. Instructions for the finish end (the pulley-support end) begin on page 6.

12. Assemble the start end of the tank (Figure 7):
 - a. Place a 5" PVC pipe (Part 106) into the top of each four-way connector.
 - b. Place an elbow (Part 108) on one 5" pipe with the end facing inward.
 - c. Attach a 12" pipe (Part 105) to the elbow coupling and complete the assembly by connecting the second 5" pipe and the 12" pipe with a second elbow coupling.
 - d. Bend a plastic splash guard (Part 113) and insert it at the very end of the tank on the inside. Line up the end holes on the sides of the splash guard with the holes in the four-way connector.
 - e. Insert rubber plugs (Part 115) into each side to hold the splash guard in place.



Figure 7

13. Set up the tank support planks (Figure 8 on next page).
 - a. Place the 18 wooden spacer blocks (Part 112) under the tank. There should be three blocks for each of the six sections of the tank. Place the two end blocks as close as possible to the U yokes and center the third block.

- b. Angle the first tank support plank so it will slide under the first of the six sections of the tank, and lay it on the three spacer blocks. Repeat this with the other five planks so it forms a continuous support base for the tank.

Note: If you plan to assemble and disassemble your AquaTrak for each use, you can decrease your assembly time slightly by gluing the spacer blocks to the support planks. Also, if you wish, you may wait to complete Step 13 until the very end of the assembly process, after the pulley assembly is in place.

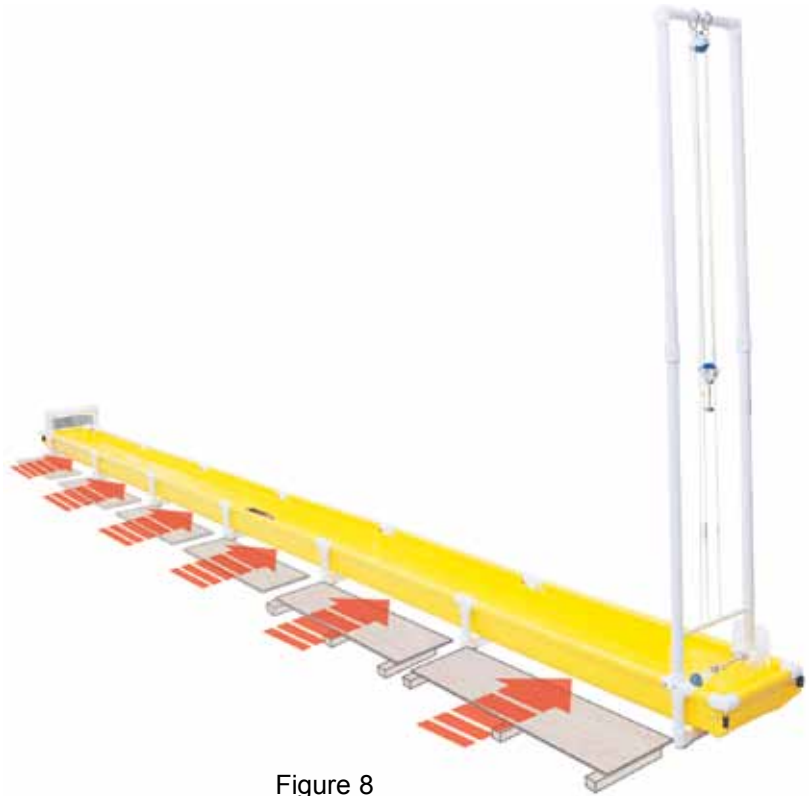


Figure 8

Pulley System Assembly

The following parts are required to assemble the pulley system:

Part No.	Qty	Part Description
102	2	38" PVC pipes without holes
104	2	38" PVC pipes with 5/8" holes
105	1	12" PVC pipe
107	2	PVC straight couplings
108	2	PVC 90° elbows
109	1	14-1/2" x 1/2" CPVC pipe
113	1	Flexible plastic splash guard
115	1	Rubber plug
116	1	Lower line guide pulley assembly
117	2	Pulley-block assemblies, one with hook
118	2	Spring assemblies
119	2	Brass weight sets
122	1	30' pulley line
124	2	7' lengths of fishing line

2. Insert one end of the 14-1/2" CPVC pipe (Part 109) into the 5/8" hole (Figure 9).
3. Place a second 38" pipe into the other four-way connector, and secure the other end of the CPVC pipe into the 5/8" hole (Figure 9). This will serve as the support bar for the pulley guidelines.



Figure 9

Assemble the pulley system at the finish end of the tank as follows:

1. Insert a 38" PVC pipe with 5/8" hole (Part 104) with the hole at the bottom, facing the inside of the tank, into the top of one of the four-way connectors.

4. Place the two straight couplings (Part 107) on top of the 38" pipes.
5. Insert two more 38" pipes on top of the couplings. Seat with the hammer, if necessary.
6. Form the top of the support: Place an elbow (Part 108) on one end. Slide a 12" pipe into the elbow coupling and slide the following onto the 12" pipe: spring assembly (Part 118), top pulley block (Part 117) (hang it from attached hook), second spring assembly. Finish by adding the second elbow and securing it to the other 38" pipe (Figure 10).

Note: The top pulley block MUST be oriented so that the line tie-off lug (see arrow in Figure 10) is facing toward the INSIDE of the tank. Otherwise, the pulley cannot be threaded properly.

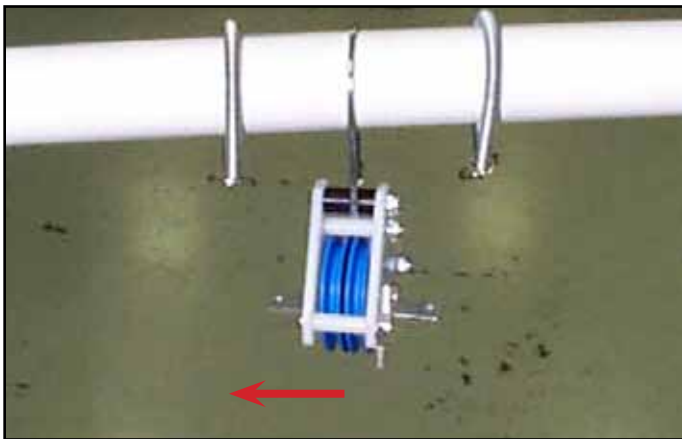


Figure 10

7. Install remaining splash guard. Viewing from the end of the tank, insert the rubber plug into the hole on the left side of the splash guard.



Figure 11

8. Install lower line-guide assembly (Part 116). Remove the outer wing nut, flat washer, and star washer. Viewing from the end of the tank, slide the assembly support bar through the right side of the splash guard and through the holes in the right four-way connector to the outside. Replace the star washer, flat washer, and wing nut – in that order – and tighten (Figure 11).
9. Align line guide pulley so it is in the center of the tank. Adjust with the two wing nuts.
10. Uncoil the 30' pulley line (Part 122) and position it so the loop and the line stop bead are at the start end of the track.
11. Thread the pulleys following substeps a-f. It helps to have someone hold the bottom pulley block in place until the pulleys are threaded.
 - a. Thread the free end of the line under the line stop guide and up and around the line guide pulley (Figure 12).



Figure 12

- b. Pull the line up to the top pulley block and thread it over the pulley on the side opposite the line tie-off lug. Thread from inside to outside (Figure 13).



Figure 13

- c. Bring the line down to the same side of the bottom pulley; thread it under and up to the outside of the top pulley (Figure 14).

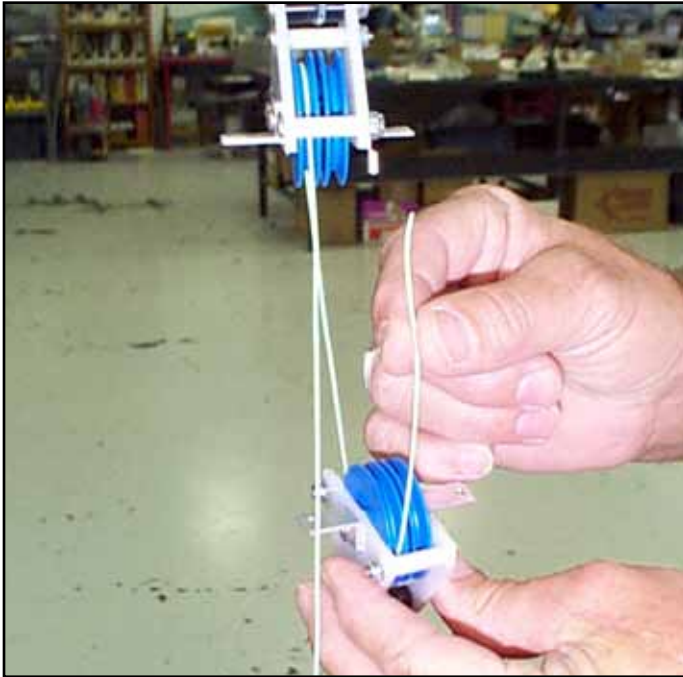


Figure 14

- d. Thread the line over the top pulley on the side nearest the tie-off and down to the inside of the tank (Figure 15).

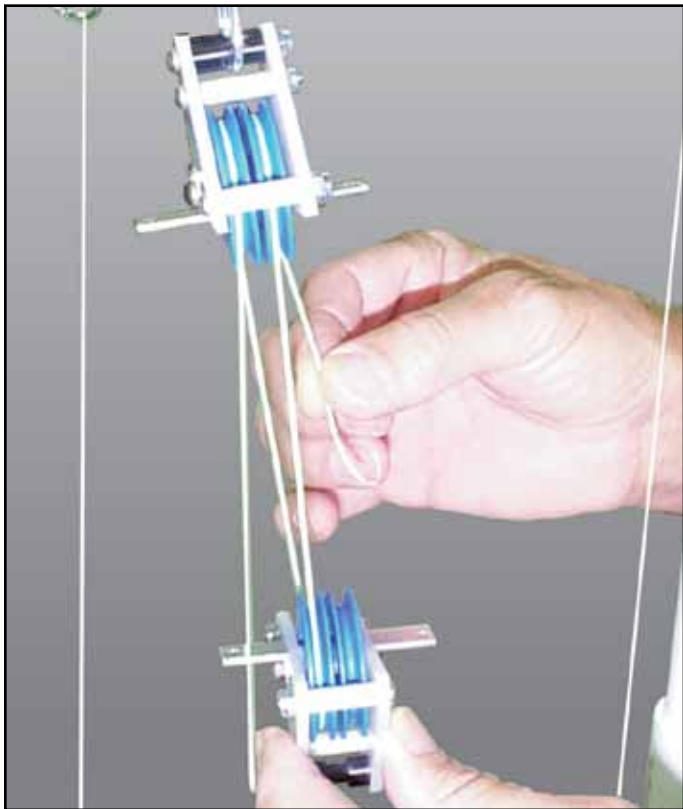


Figure 15

- e. Thread the line down and around the second bottom pulley and up on the inside (Figure 16).

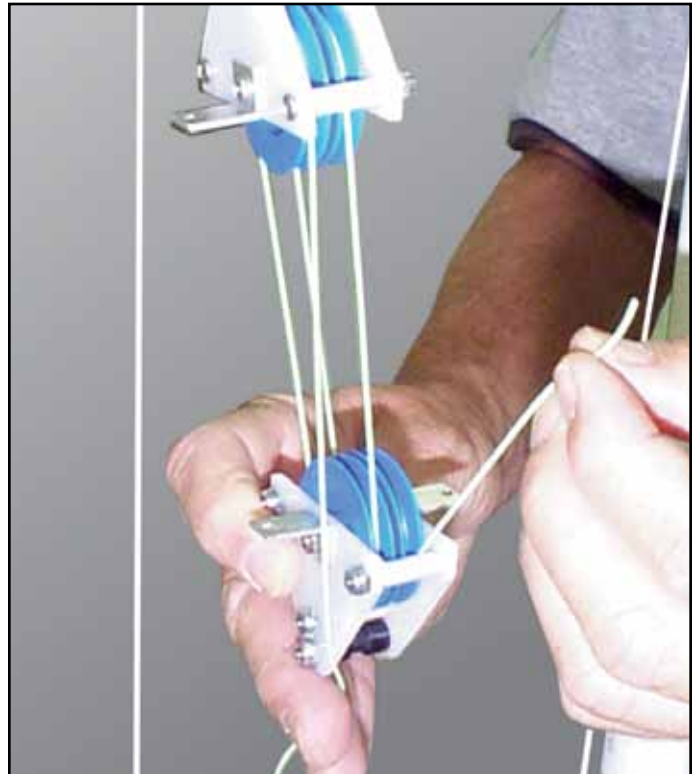


Figure 16

- f. Pull the line up to the top pulley and thread it through the tube in the tie-off lug (Figure 17). When the line is through the lug, pull the two pulley blocks apart until the lower block hangs 7" to 8" above the guideline support bar at the bottom. Tie a knot in the end of the line to hold it in place at the tie-off lug.

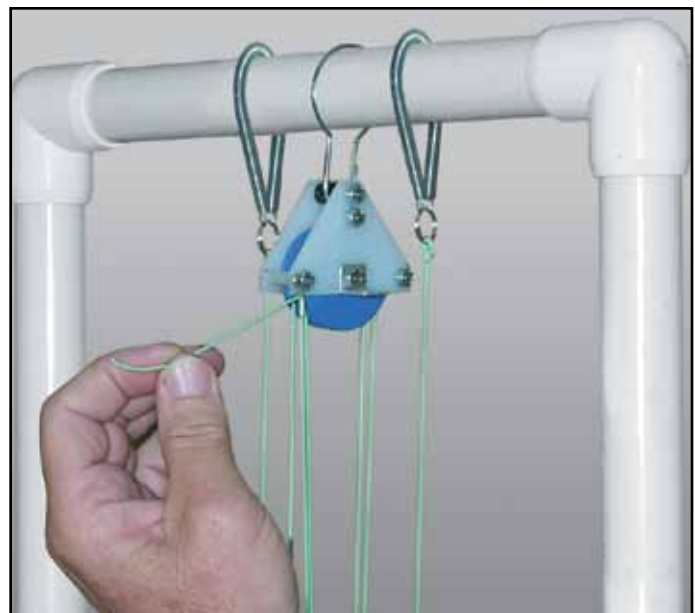


Figure 17

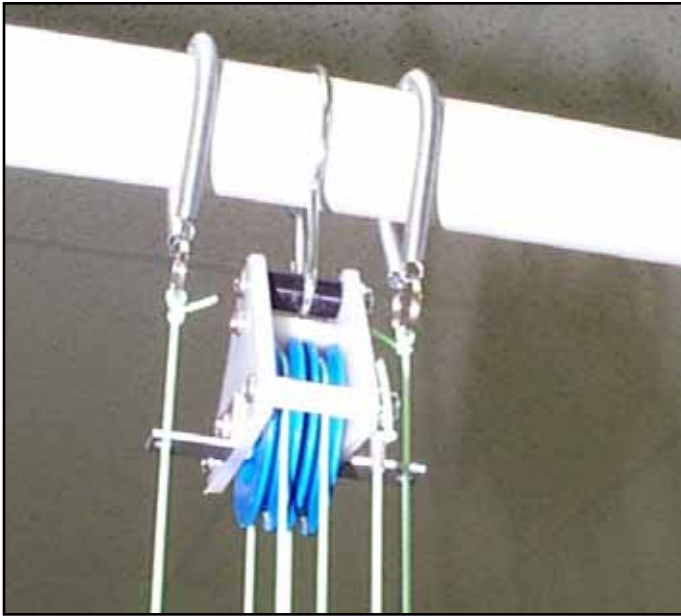


Figure 18

12. Attach a brass weight set (Part 119) to the bar on the bottom pulley block (see Figure 19 for placement of weight set).
13. Attach pulley block guidelines. Knot the end of a seven-foot length of fishing line (Part 124) to the ring at the base of one of the springs. Pull the line down (keeping a slight tension on the spring) and thread it through the metal angle irons on both the top and bottom pulley blocks (Figure 18). Make the line taut and tie it at the base by knotting it around the guideline support bar. Repeat the process for the other spring. These guidelines will prevent the pulley strands from tangling (see Figure 19 for the bottom of guideline assembly).

Note: If you have not yet inserted the spacer blocks and tank support planks under the tank, do so now (see pages 5-6 for instructions).

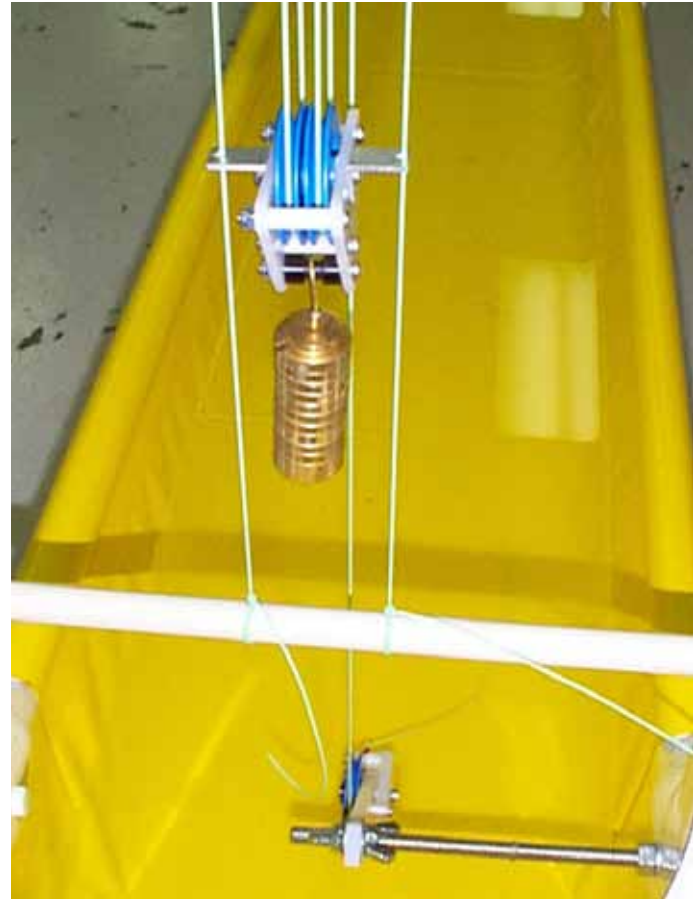


Figure 19

When the pulleys are threaded and the weights and pulley block guidelines are attached, the assembly should look like Figure 19. The free end of the pulley line is now ready to attach to a boat.

14. Attach and run a boat. To test or race a boat, attach the free end of the pulley line to the boat by threading the loop on the end of the pulley line into a screw eye or a bent paper clip mounted on the bow of the boat. Pull the pulley line to the start end and release the boat when ready.

AquaTrak Maintenance

Filling and Emptying the Tank

To float your boat easily along the AquaTrak with minimum spillage, a depth of three to four inches of water is best. The tank can be filled using the five-gallon buckets included in the A.T.A.K. – AquaTrak Accessory Kit, sold separately – or filled directly from the hose, which is also included in the A.T.A.K. (Figure 20).

To empty the tank, attach the hose to the pump included in the A.T.A.K. and pump the water either into the A.T.A.K.'s 30-gallon tank or directly down the drain (if you're not planning to reuse it). Pumping the water out takes less than two minutes.

Disassembling and Storing the AquaTrak

The AquaTrak is easy to disassemble and store. The longest piece is only 38" long. After disassembly, everything can be returned to the shipping box and stored on a shelf in the classroom or lab.

When you've finished using the AquaTrak, be sure to rinse and dry the vinyl tank thoroughly to prevent mildew or other musty odors from developing.

Disassemble in the opposite order from assembly, dismantling the pulley system first. Carefully wind the pulley lines to prevent tangling. Disassemble the PVC pipes from the pulley-support system and the tank-support system. (You may need to use the hammer to loosen the pipes.) Slide the tank from the PVC supports and roll it up. Return everything to the shipping box, put it on a shelf, and you're all set until next year!



Figure 20

Getting Started with the AquaTrak

To get something into the water the first day, encourage students to bring their old toy boats from home or test objects from the lab. Try slabs of balsa wood, varying one factor at a time, such as size or shape.

Choose a single size and vary the material (balsa wood, basswood, and foam). Attach the front of the test object to the pulley line using a bent paper clip or a small screw eye. Observe differences in the wakes of each object – smooth or choppy, large or small – and measure their speeds with a stopwatch.

As soon as possible, involve students in the design and testing of their own boats.

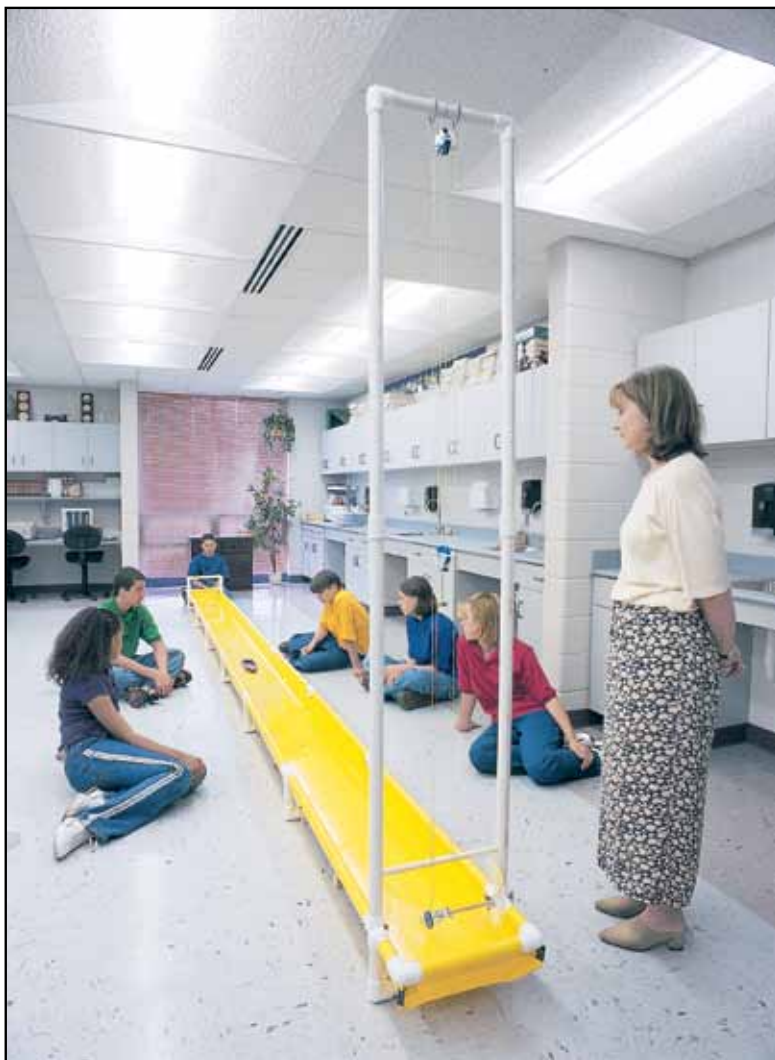
To conform best to the AquaTrak's size, boats should be 12" or less in length. Design specifications can be based on the age and ability of the students, but minimum requirements should include symmetry (both sides the same), a pointed bow, and a rounded stern. The most common bottom types include flat, rounded, and V-bottom.

Stress to students that they may design their boats to optimize for one of several different factors: speed, stability, load-bearing capacity, or others.

A good starting point is Pitsco's Boat Hull Design Kit, which includes a block of foam for a prototype and a block of wood for carving the completed boat design. The construction manual includes brief instructions for designing scale models on paper and several sample designs.

Designing their own boats from scratch will add considerably to students' fun and to their learning. To facilitate the design process (with or without the Hull Design Kit), use the guidelines provided in Pitsco's exclusive interdisciplinary curriculum, *Boat Design and Testing: From AquaTrak to the Oceans*. Make design books available for students to study (see references in the curriculum and in the Pitsco catalog) and/or have them research boat building online.

When the boats are in the water, give students the opportunity to test their own designs with the fully developed activities in *Boat Design and Testing: From AquaTrak to the Oceans*.





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