HOW & WHY YOU MIGHT SINK AND DIE!

Weight of Water = 62 lbs./cu. ft.

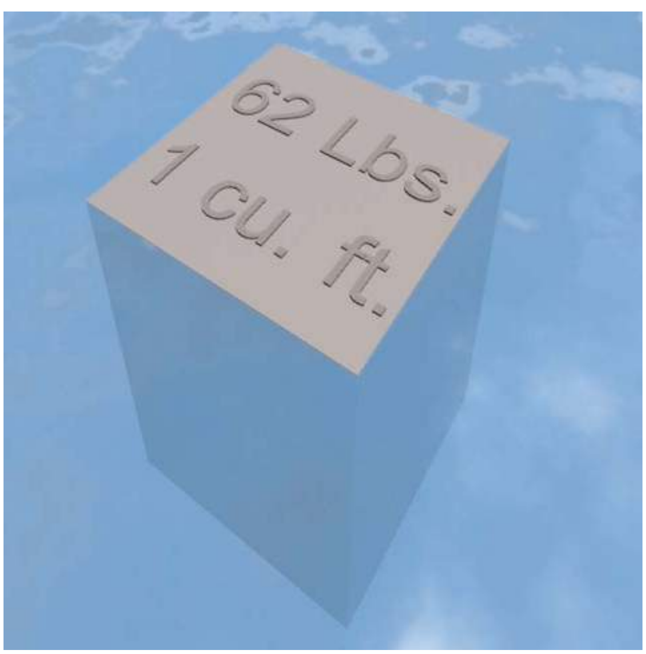
BOYANCY- an upward force on an object immersed in a fluid.

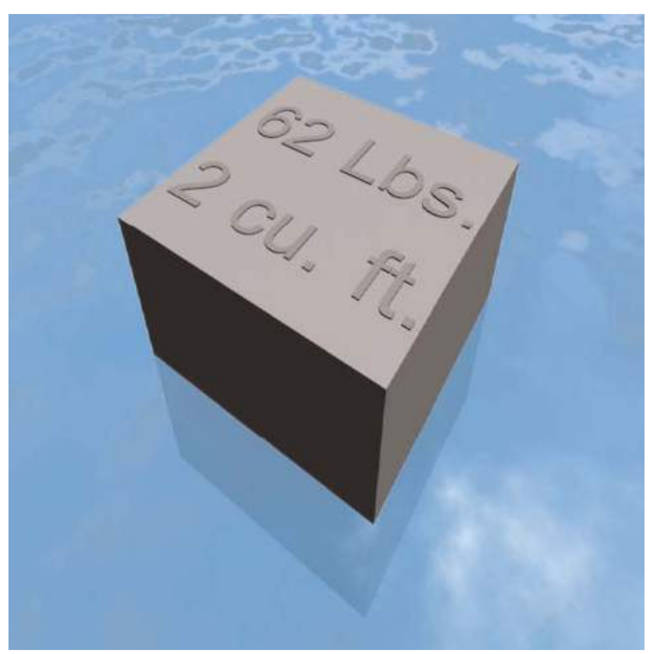
DISPLACMENT- the pushing away of a fluid when an object is immersed in it

VOLUME- is a measurement of how much space an object occupies

Archimedes Principle states that the buoyant force on a submerged object is equal to the weight of the fluid that is displaced by the object. For example, 1 cu. ft. of water weighs 62 lbs. Transversely, an object with 1 cu. ft. of volume will displace 62 lbs. of water. This means a 1 cu. ft. box will hold up to 62 lbs. before sinking. That box will sit with its top flush with the water's surface if it is supporting 62 lbs. If the box were 2 cu. ft. in volume it would float ½ out of the water.

How much would a 1 cu. ft. box weigh if it floated ½ way submerged in water?

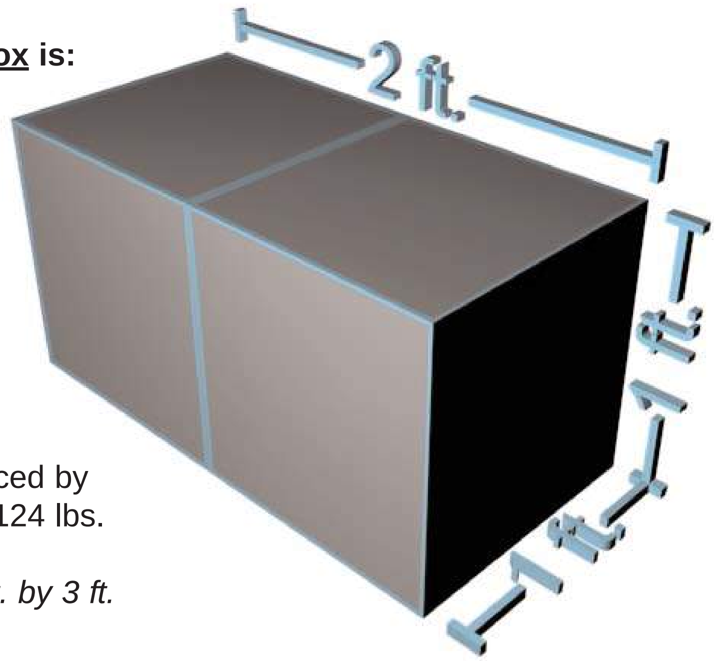




"CALCULATING BOYANCY"

To calculate buoyancy you need to determine the relationship between weight and volume. The weight of the vehicle is most easily calculated with a scale. To calculate the amount of weight the pontoons, boat hull, or other flotation objects can float you need to multiply their volume by 62 lbs. per qu. ft.

For example, we will calculate the buoyancy of a box that is 1ft. by 1ft. by 2ft.

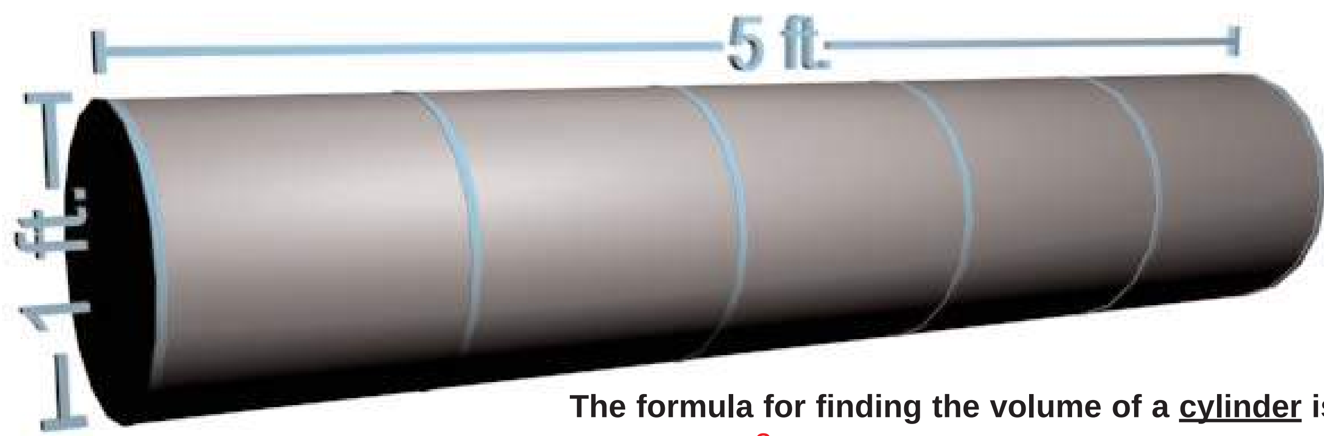


The formula for calculating the volume of a box is:
Length*Height*Width=Volume
1 ft. * 1 ft. * 2 ft. = V
1 sq. ft.* 2 ft. = V
2 cu. ft. = V

Volume*62lbs/qu. ft.=Displacement
2cu. ft. * 62 lbs. = D
124lbs = D

In other words, the box will hold 124 lbs. before submerging entirely. The 124 lbs. of water displaced by the box returns a buoyant force up that will hold 124 lbs.

Find the displacement of a box that is 2 ft. by 2 ft. by 3 ft.



The formula for finding the volume of a cylinder is:
(3.14*Radius^2)*Length=Volume
3.14 * .5^2 ft. * 5 ft. = V
3.14* .25 ft. * 5 ft. = V
.875 sq. ft. * 5 ft. = V
3.925 qu. ft. = V

Find the displacement of this cylinder.

The formula for finding the volume of a <u>triangular prism</u> is:

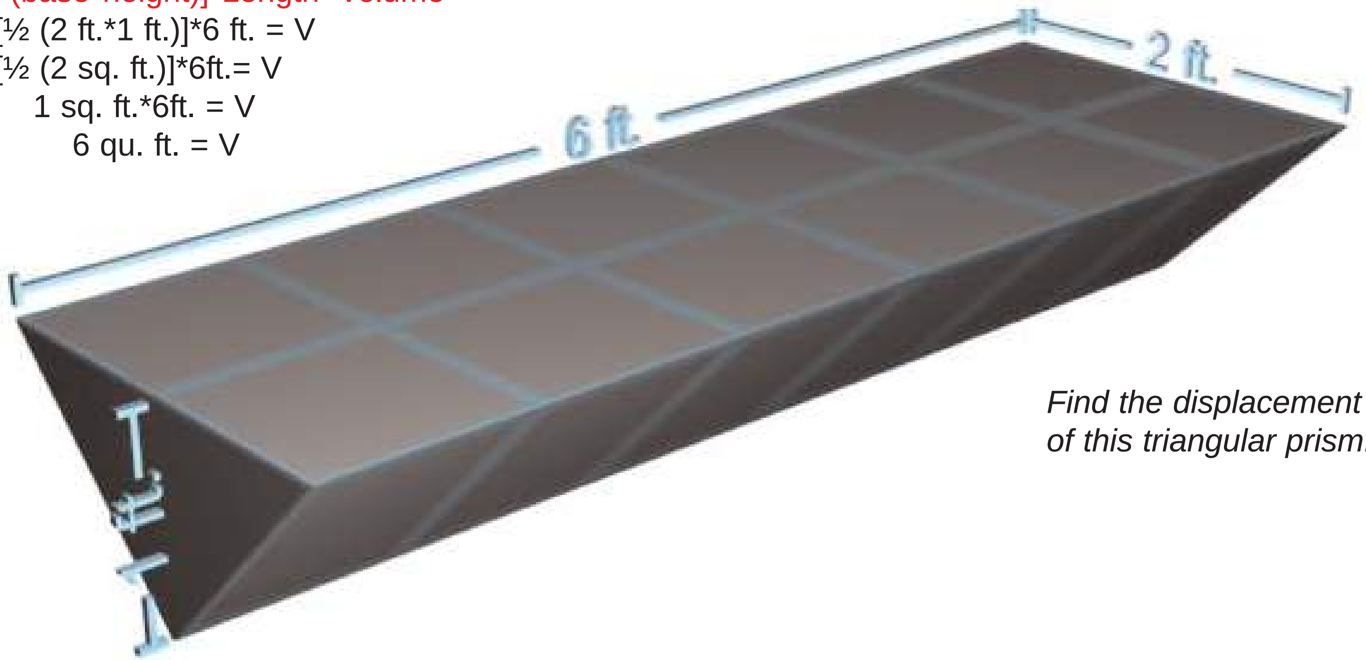
[½ (base*height)]*Length=Volume

[½ (2 ft.*1 ft.)]*6 ft. = V

[½ (2 sq. ft.)]*6ft.= V

1 sq. ft.*6ft. = V

6 qu. ft. = V



Find the displacement of this triangular prism.

The formula for finding the volume of a <u>trapezoidal prism</u> is:

[½ (base 1+base 2)]*Height*Length=Volume

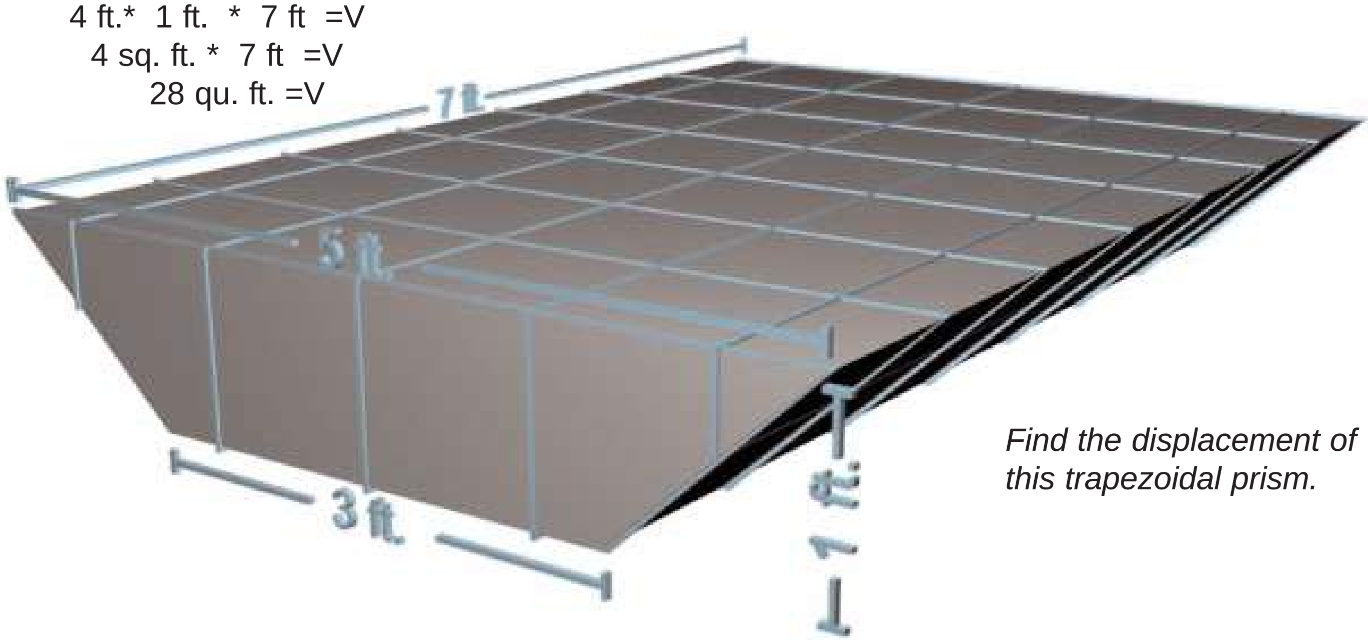
[½ (5 ft.+3 ft.)]* 1 ft. * 7 ft =V

[½ (8 ft.)]* 1 ft. * 7 ft =V

4 ft.* 1 ft. * 7 ft =V

4 sq. ft. * 7 ft =V

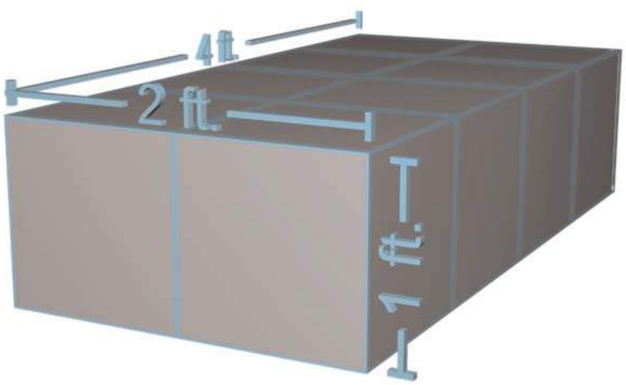
28 qu. ft. =V

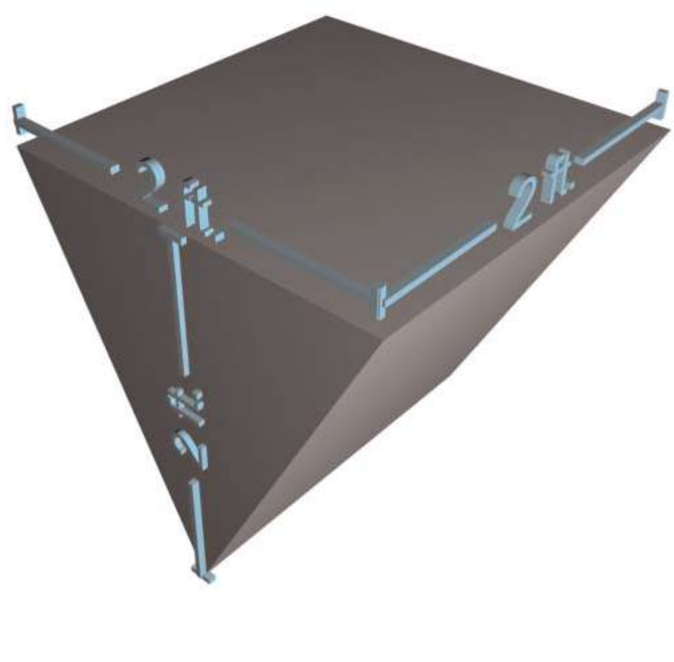


Find the displacement of this trapezoidal prism.

SHOW ME DON'T TELL ME

*Calculate the **volume** and **displacement** for each of the following forms.*



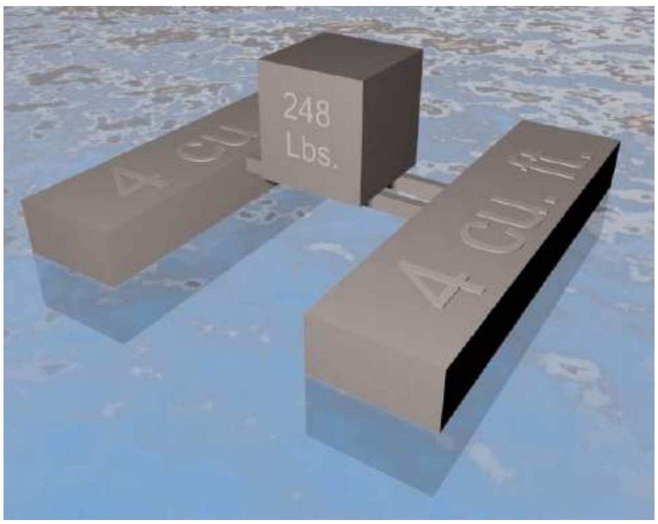


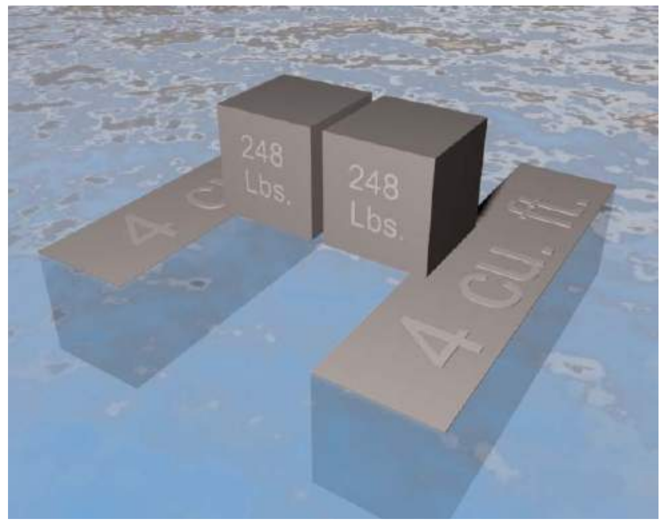
"PONTOON EFFECT"

These images show what the "pontoon effect" is and the importance of having each pontoon be capable of supporting the entire weight of the vehicle. While this example uses a catamaran style design for floatation, the principals can be applied to most floatation schemes. In this example each pontoon is 4 cu. ft. in volume meaning it will displace up to 248 lbs. of water. (4 cu. ft.)*(62 lbs.)=248 lbs.

What would be the maximum displacement of a 5 cu. ft. pontoon?

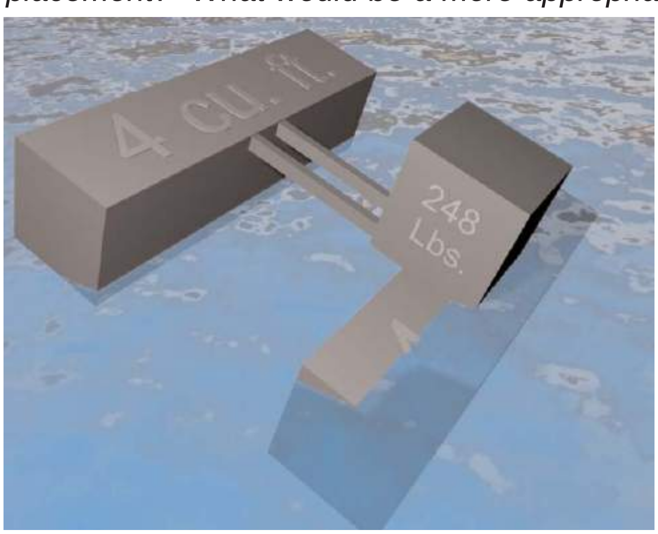
When the two pontoons are loaded with ½ of their maximum weight they sit ½ way out of the water. 1/2(248 lbs.)=124 lbs. each or 248 lbs. total. If all the weight is shifted to one of the pontoons, it is unlikely the pontoon will fully submerge. If the pontoon were to fully submerge the stability of the vehicle would be lost. Wind, the rocking of a wave, shifting position of the passenger, and entering or exiting the water on ramps all have the potential to put all of the vehicles weight on one pontoon.

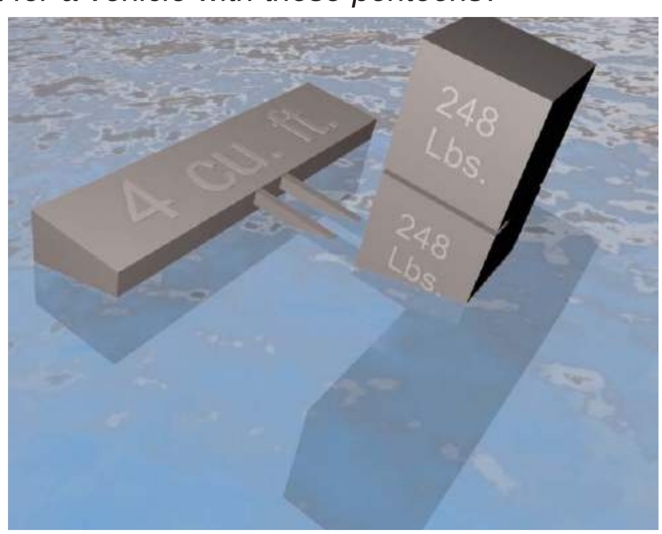




The second two images show the effect of 100% load. When perfectly stable the pontoons sit with their tops flush with the surface of the water. With the slightest shift of weight the pontoon goes under and stability is lost.

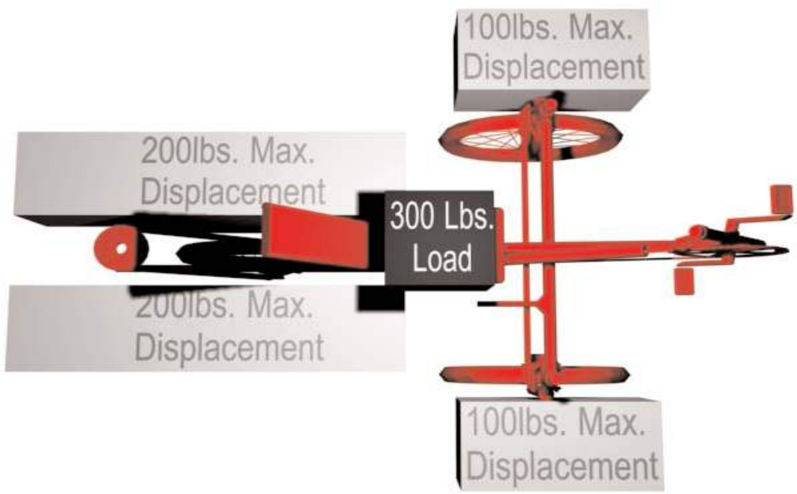
Why would it be unwise to build a 500 lbs. vehicle with 2 pontoons, each capable of 250 lbs. of displacement? What would be a more appropriate weight for a vehicle with those pontoons?





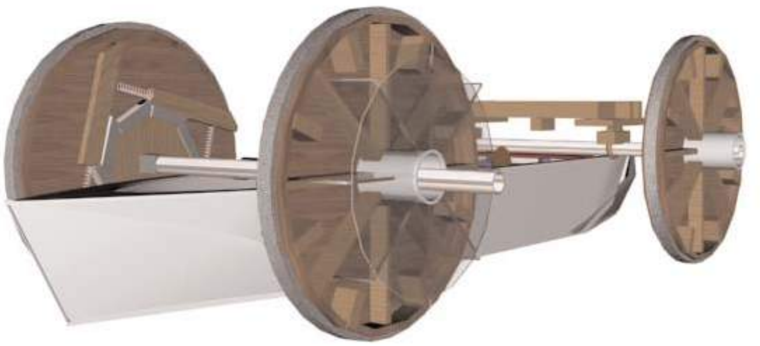
"PONTOON EFFECT" CASE STUDY

This example is of a recumbent tricycle design that, while great on land, was less then successful during it's water entry. The vehicle weighed a total of 300 lbs. with the rider. Each of the front wheels had a pontoon with a maximum displacement of 100 lbs. the back wheel had a pontoon on each side, each with a maximum buoyancy of 200 lbs. Overall the vehicle weighed ½ of it's maximum displacement. 2(100 lbs.)+2(200 lbs.)=600 lbs.



What went wrong? While the vehicle had plenty of displacement overall, the front two pontoons were only capable of displacing 200 lbs. total. The vehicle weighed 300 lbs. As it went down the ramp into the water, the front pontoons met the water and were totally submerged before the rear pontoons were able to help support the weight. When the rear pontoons did meet the water their buoyancy only helped keep the back of the boat up, pushing the front of the boat down. The vehicle remained leaning forward which kept the weight of the vehicle on the front pontoons. While the angled entry down the ramp assured the design flaw would be realized, the placement of the main weight (the rider) mostly over the front pontoons was just as likely to trigger the failure.

What would have been the necessary combined displacement of the front pontoons to correct this design flaw?



PADDLE WHEELS CASE STUDY

The paddle wheels on the vehicle above were well placed and pushed a lot of water. They were so powerful that they could not be powered by the peddle drive train but had to be pushed by hand.

The vehicle on the left had simple paddle wheels mounted straight to a jackshaft already in the drive train. In both buoyancy calculations and water tests the expected waterline put about 1/3 of the paddle wheel submerged. Unfortunately some last minute alterations to the vehicle increased the weight in the rear. The actual waterline was higher and left the paddle wheels fully submerged and useless. The pilot prevailed and used an oar to successfully navigate the water.

Propellers and paddle wheels are by no means the only choices for water prolusion. Pumps that take water in at the front of the vehicle and push it out in the back are a possibility. Most sea life get around with out propellers or paddle wheels. How do they do it?