



# Breath Blown Boats = $\frac{d^3B}{dt^3}$

**Purpose** – To construct a boat that is raced down a water filled gutter, propelled solely by blowing into the boat's sail.

The boats are raced in a standard rain gutter that is ten feet long, placed on top of lab tables and filled ½" - 1" below the top with water. The boats are propelled by directly blowing into the sail. The boat cannot be touched while racing. The first boat to reach the end of the gutter is the winner. The overall winner is determined by an elimination system.

## Recall

Understanding and applying principles learned over that past two years of physics will be instrumental in the success of your boat's design and performance. Recall the following principles:

1. The acceleration of an object is directly proportional to the net force and inversely proportional to the mass.

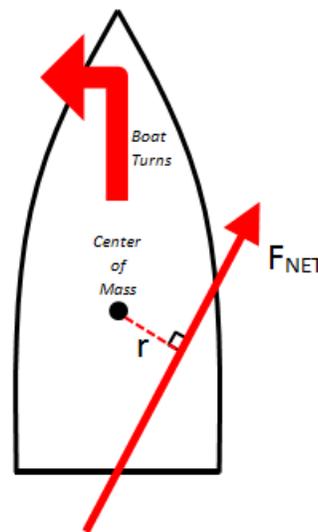
$$a = \frac{F_{NET}}{mass}$$

2. The change in an object's momentum is equal to the product of the net force and time of application.

$$\Delta p = F_{NET} \times time$$

3. The direction of the net force and acceleration are allows in the same direction. If the net force acts through the center of mass, the object experiences no net torque. If the net force is applied such that it does not pass through the center of mass, a torque arises and the boat will turn.

$$\tau = rF_{NET}$$



4. The percentage of boat that is submerged in the water is equal to the ratio of the boat's average density to the density of water.

$$Percentage\ Submerged = \frac{\rho_{Boat's\ Average}}{\rho_{Water}}$$

5. The drag force on the boat through the water is related to the density of the medium, speed of the boat, cross sectional area and surface texture.

$$F_{Drag} \propto (\rho_{Water})(v)(A_{Cross\ Sectional})$$

## Requirements

- **Length** - The maximum length of the boat from bow to rudder is 7 inches.
- **Mast** - Height limit is 6" (maximum) from deck to top (a mast may not be necessary for your boat's design).
- **Sail** - The sail must be constructed from a 4"X6" notecard. The entire notecard does not have to be used in the construction of the sail.
- **Rudder and Keel** (Optional) - A keel or rudder must be securely attached to the bottom of the boat. The rudder may extend beyond the stern (rear) of the hull.
- **Width** - Maximum boat hull width (not counting sail) is 2.5 inches.
- **Motors** - No motors or other power sources allowed, boats must run on AP Physics Student's breath power only
- **Decorations** - Boats may be decorated and painted but NO WATER-BASED PAINT.
- **Weight** - No restrictions on weight

## Materials and Construction

- No prebuilt boats
- No toy boat parts – hulls
- **No Styrofoam** is allowed (examples: foam cups, food containers, packing peanuts, hard foam packing)
- The boat must withstand several days of student testing and at least 2 days of teacher evaluation.

## Grading

Grades are based on the ability of your boat to complete the race and your ranking.

Time to Transverse the Gutter	Grade
First Place*	100
Second Place*	99
Third Place*	98
Time < 5 seconds	97
5 seconds < time < 10 seconds	95
10 seconds < time < 20 seconds	90
20 seconds < time < 30 seconds	80
>30 seconds	70

\*Boats that are ejected from the track while racing are ineligible to place.