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1 HOUR

How to stop sailboats capsizing

Materials

- Sponge cloth
- Toothpick
- Cork
- 4x Wall pins / Small nails
- Tin foil

Activity Overview

- This activity involves building a sailboat
- Create this experiment and see how your sailboat remains upright

Activity Plan

- Poke a toothpick in the centre of the cork so it sticks upright. This will be your boat's mast.
- Cut a square of your dry waterproof material (sponge cloth) approximately 6 centimeters square. Poke the toothpick through opposite ends to create your sail.
- You've made a sail boat! Place it in water and blow on it from behind. What happens? Chances are it tipped over! We will need to add something to fix this.
- Carefully start adding the nails/pins to the bottom of the cork in a straight line then place your sailboat back in the water. Does your boat move in a straight line?
- Your sailboat needs a keel! Connect your nails/pins together with a square piece of tin foil. Tightly wrap the tin foil around the nails/pins to make a fin shape.
- Place your boat back in the water and blow on it from behind. Does the keel help it move in a straight line?
- Try experimenting with a bigger sail, and altering your keel to compensate for this.

Reflective Questions

- Why would adding the keel stop the sailboat from capsizing?
- Is the direction of the wind important?
- Can sailboats move faster than the wind?
- What is a rudder used for on a sailboat, and where is it located?

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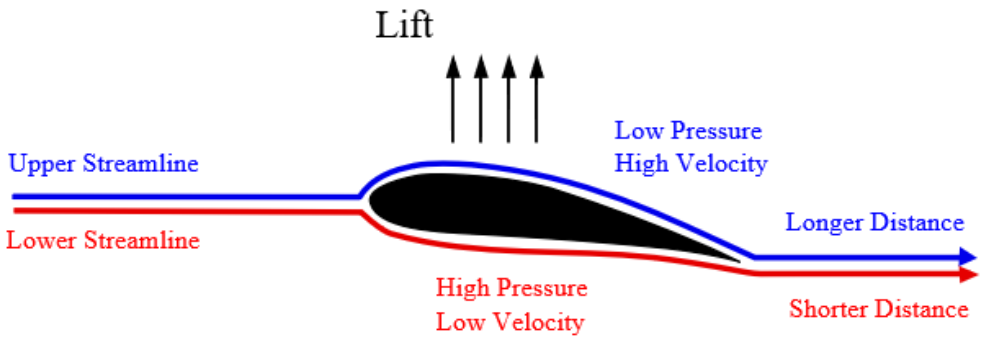
How do sailboats move forward?

Sailboats are able to move by travelling in the same direction as the wind. However, they often need to move forward regardless of wind direction. So how do they achieve this?

Sails work in the same way as plane wings, shown in the diagram below. Due to its shape, the air travelling over the wing moves faster than the air travelling under the wing. This results in the air pressure above the wing being lower. The higher air pressure below then pushes the wing upwards, allowing the plane to fly. This is known as 'lift'. This can be seen by holding a piece of paper at one end and allowing the other end of the paper to fold down naturally. Blowing over the top of the paper will lift the lower hanging end.

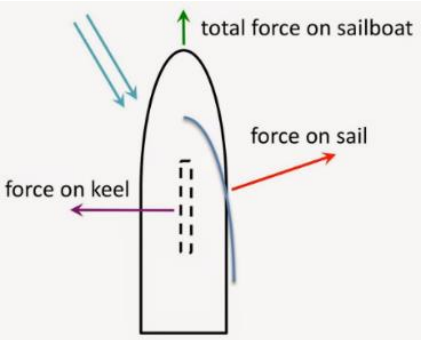


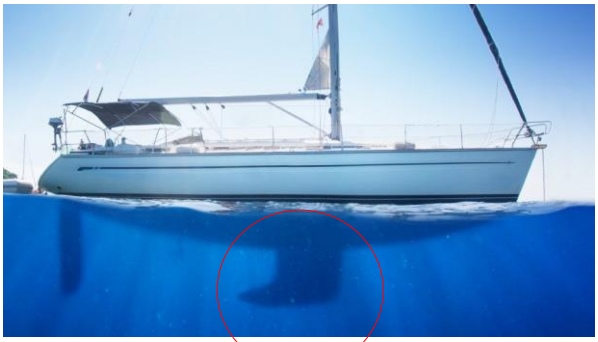
Now imagine a sail is a plane wing on its side, where lift is a sideways force instead of an upwards force. But because the wind typically hits the sail from an angle, this means the lift is both in a sideways and forward direction. So there needs to be a solution to stop the boat drifting sideways and to only move forward.

Why do sailboats need a keel?

The keel has two main functions: to keep the boat from being blown sideways in the wind and to keep the boat upright. The keel is fixed to the bottom centre of the sailboat, providing the sideways resistance needed to counter the force on the sails.

So how does the keel help the sailboat go straight forward? The keel also acts as a wing and develops its own lift underwater in the opposite direction of the sail's lift. Both keel and sail create a combination of forces in the forward and sideways directions. Their sideways forces are in opposite directions so they cancel each other out, leaving only the forward forces.





Keels carry ballast (gives the boat stability) by being made from a heavy material. The keel's broad, flat surface helps create sideways force by displacing water in the opposite direction that the boat is leaning. Although the keel is much smaller than the sails, the density of the water allow its force to be strong enough to stop the sailboat capsizing.