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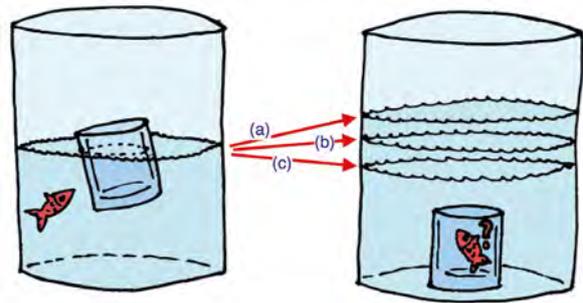
Sinking with the Titanic

In the *Titanic* movie, when the rear part of the ship is about to sink, Jack Dawson (Leonardo DiCaprio) says to Rose DeWitt Bukater (Kate Winslet) to get ready to swim, because the sinking body will suck them into the abysses. Is this sucking phenomenon really happening? And, if so, why?

The occurrence of the sucking is certain. In his memories [1], Tameichi Hara describes his experience of jumping off a sinking boat, and of the resulting sucking vortex. The presence of such a phenomenon is also the subject of a MythBuster episode [2] that negates this effect, but uses a small boat.

Searching on Internet, one can generally find three types of explanation. The first one refers to the air contained in the boat, which – while escaping during the sinking – would lower the density of water. The second is that water, entering the void spaces inside the ship, would suck people inside. The third is related to the viscous drag effect that causes a vortex behind a body moving through a fluid. It is the same effect which, in a convertible car /cabriolet, makes long hair whip one's own face. It is easy to visualize this by blowing at a candle behind a hand (*i.e.*, changing the reference frame), or moving a hand in water containing small floating objects.

This effect also depends on the speed of the moving object, at least for small velocities.



However, there is a more conspicuous effect due to Archimedes that is generally ignored (somehow related to the “sucking void effect”). If one wants to perform this “show”, I suggest buying the “Tubtanic” bath plug [3], for the initial introduction. One also needs an “iceberg” (to be used for the introduction and the final challenge), a transparent cylinder and a glass with a diameter about half that of the cylinder and a thick bottom (for stability and for displacing more water).



[Everyday physics]

Fill the cylinder half with water and let the glass (our Titanic) float. Mark the water level with a whiteboard marker and ask the audience to vote for three possible answers to the question: If I let the glass sink, what will the water level be after sinking of the 'Titanic' (see Figure p.30)? Will it be (a) higher than the current level, (b) the same, or (c) lower?

Surprisingly, I found that most people choose answer (a), but the experience shows that the "sea level" is lower after the sinking (the effect is more easily visible if the glass is displacing a large mass of water and if the cylinder is tight).

The explanation implies a quick recall of Archimedes' law: the buoyant force exerted on a body immersed in a fluid is equal to the weight of the fluid that the body displaces. This force is equal to the weight of the glass. But because of the larger density of the glass, it displaces a mass of water which is larger than its own mass, an action that is obviously possible due to the air-filled part. After sinking, the glass only displaces a mass of water equal to its own volume, and the water level lowers. For a sinking ship, this means that it tends to dig a "hole" in the ocean, which is immediately filled by the neighbouring water. This effect, like the drag effect, depends on the speed of sinking, so it is difficult to distinguish between the two.

After performing this experiment, one can remove the glass, put the "iceberg" inside the cylinder, mark the water level again and ask for a first challenge: what will happen to the water level after the ice has melted? One has to wait for a while, so it is convenient to perform this experiment at the beginning of the show, collect the answers and return to this subject at the end.

And now a final challenge: put a golf ball in a glass and add salt so that it just floats. What will happen to the ball if one pours some additional lighter liquid (oil or liquid soap) in the glass [4]? Will it (a) rise, (b) stay the same or (c) sink? ■

References

- [1] Tameichi Hara, Japanese Destroyer Captain, Ballantine Books, New York & Toronto, 1961 . ISBN 0-345-27894-1.
- [2] <http://www.discovery.com/tv-shows/mythbusters/videos/sinking-titanic-minimyth.htm>
- [3] <http://www.amazon.co.uk/Paladone-PP0258-Tubtanic-Bath-Plug/dp/B003Y3Q1GW>
- [4] This quiz is taken from Veritasium https://www.youtube.com/watch?v=C_covjlcZ4

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