Safety on ships: The 'load line'

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Archimedes states "**An object in a fluid experiences an upward force equal to the weight of the fluid *displaced* by the object**"

Getting safer ships

The marking of ships to indicate how low or high they may safely rest in the water when loaded goes back several centuries.

The first seafarers who set out to sea in wooden canoes thousands of years ago must have already - perhaps by trial and error - worked out the optimum freeboard (see sideline science) for these vessels.

A bit of history…

Crete 2500 BC - vessels were required to pass loading and maintenance inspections.

Venice middle ages - laws requiring vessels to be loaded to a maximum depth shown by a line marked on the side of the hull.

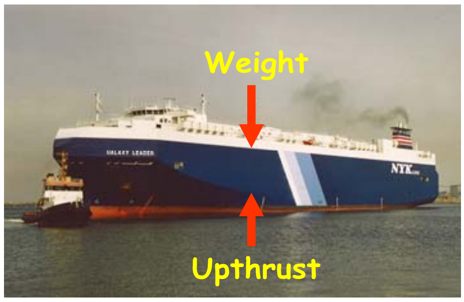
Copenhagen 1561 - a captain could be fined "for overburdening his ship".

London 1835 - loading recommendations were introduced.

In the UK in 1876 the Merchant Shipping Act made load lines compulsory. This became known as the "Plimsoll Line" (named after the MP Samuel Plimsoll who was the Merchant Shipping representative at the time): a circle with a horizontal line through the middle. Plimsoll lines are now known as 'load lines'.

Sideline Science…

The science of buoyancy:
If the weight of water displaced by the boat equals the upward force of the water then the boat will float!



Freeboard:
The distance between the top of the ships hull and the waterline divided by 12. As ships are loaded, they sink deeper into the water so the freeboard is reduced. This can be dangerous

The Load line:
The purpose of the load line is to ensure that a ship has sufficient freeboard and thus sufficient reserve buoyancy and stability during sailing.

The load line makes it easy to see whether a ship has been over or under loaded. It was named after Samuel Plimsoll - the Merchant Shipping MP (pictured)

What actually happens if you overload a ship?

If you overload a ship and there is insufficient **freeboard** (the distance between the surface of the water and the top of the ships hull) water is more likely to get onto the deck. This increases the ships weight and may cause the ship to sink!

An example of this happening is pictured left:

What actually happens if you under load a ship?

If you under load a ship and there is too much freeboard, ships are likely to be unstable at sea and are more likely to capsize.

Time for something practical…

You will now work out the load line of the ship you have previously made in a range of different bodies of water

Step 1 – Measure the depth of your boat (the freeboard) in ***mm*** in each body of water

Step 2 – Divide the answer by 12 to work out the size of the load line in each body of water

Step 3 – Measure from the top of the boat the freeboard distance and draw a pencil line across the full length of the boat at that point. This will show you your load line. Use a ruler or tape measure to ensure your calculation is accurate

Measuring the maximum load capacity of your ships

- Give your boat a name and place it in turn in each body of water again
- This time add cargo (metal nuts) one at a time until the boat sinks to the load line. Weigh the cargo in ***g***
- Record your results in the table provided below for each body of water

Water type	Freeboard (mm)	Cargo load (g)
Cold, freshwater		
Cold, saltwater		
Hot, freshwater		
Hot, saltwater		

The name of our ship is____

Now answer this question…

1. What do you notice about the freeboard of your ship in different bodies of water and why do you think this is? (link your answer to key terms such as density, salinity and temperature).