XAVIOUR'S LAW OF FLOATATION

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ABSTRACT: Xaviour's law of floatation is my new physics law that explains how does an object gets floating capacity and why the shape of an object helps to floatation. That is how an object which naturally have non floating characteristic, can reaches the floating capacity. When the air is added to an object, what change takes place on its body, especially in its density? What is the role of air on object during the floatation? Floatation can be defined as the tendency of an object to rise up to the upper levels of the fluid or to stay on the surface of the fluid. The opposite of floatation is sinking and can be defined as the tendency of an object to go to the lower levels of the fluid. Archimedes's principle gives the explanation about what will happen at an object interact with fluid. But, Xaviour's law of floatation gives a new way to find out the average density (new concept) of floating object.

XAVIOUR'S LAW OF FLOATATION:

- At not exit condition, when the air is sealed within an object, the density of air along with the density of object reaches the average density.

$$Dfo = \frac{\Sigma Dm}{N}$$

- If this average density is less than the density of fluid, that object will float.

$$Dfo < Df$$

[Dfo – Density of floating object; Dm – Density of medium; ΣDm – Sum of the density of medium; N – Number of medium; Df – Density of fluid]

EXPLANATION:

Till now science is telling various concepts about flotation. Floatation is the ability to stay on the soft ground. For example, a tightly closed empty glass bottle floats on the surface of water. In the same bottle, if a hole occurs, it will sink. Why is this happening? Though buoyant force acts on all the floating or sinking objects, some of the objects float and some of these sink. Why is this happening? Until unbreakable, some objects float, if it breaks they will sink. What is the reason for this? Xaviour's-law of floatation is clearly explains these things.

"The gravitational attractive force acting on a body is called its weight. The weight of a body acts vertically downwards through its centre of gravity. When a body is immersed in a fluid, the fluid exerts an upward force on the body known as the force of buoyancy or up thrust. According to Archimedes' principle, the force of buoyancy is equal to the weight of the fluid displaced. The force of buoyancy acts vertically upwards through a point known as the centre of buoyancy. The centre of buoyancy is the centre of gravity of the displaced fluid. If the weight of a body is greater than the force of buoyancy acting on it, then the body will sink in the liquid. The density of the body sinking in a liquid is greater than the density of the liquid. If the weight of a body is equal to the force of buoyancy acting on it, then the body will float just inside the liquid surface. The density of the body is equal to the density of the liquid. There are two laws of floatation. The first one states that the weight of a floating body is equal to the weight of the liquid displaced. The second one states that the centre of gravity of a floating body and the centre of buoyancy are in the same vertical line.

Commonly known conditions for objects to float is, the average density of the object should be less than the density of the fluid in which the object has to float. Example, a ship is very heavy but it floats because it is hollow inside it contains air, this causes its average density to be lower than that of water. The up thrust force of the fluid on the object must be equal total weight of the object. (law of floatation) Example, a coin will sink to the bottom when placed on the surface of water, this is because the up thrust of water on coin is less than its weight. The volume of object submerged must be large so as to displace large amount of fluid. Xaviour's- law of floatation is entirely differ from, Archimede's principle. It says, "At not exit condition, when the air is sealed within an object, the density of air along with the density of object reaches the average density. (Dfo = ΣDm / N) If this average density is less than the density of fluid, that object will float. (Dfo < Df').

For example, consider a rectangular shaped tin sheet with 20cm length and 15cm width. Its thickness is 1mm and a mass 50g. Then make that sheet as a rectangular box with the size it will have to 14cm length, 9cm width and 3cm hight. Now find out this box will float or not using Xaviour's- law of floatation.

Solution:

Step-1: Find the density of the tin sheet.

Given that, length=20cm; width=15cm; mass=50g; thickness=1mm

To find the density, we have to find mass and volume. We already know the mass is 50g. So, find the volume.

Volume of rectangle is, V = l × b × h

V=20cm × 15cm × 0.1cm

V=30cm^3

So, volume of the tin sheet is 30cm^3. Now find the density of this sheet.

We know the density formula, that is, $\rho = \frac{m}{v}$

$$\rho = \frac{50g}{30cm^3}$$

$$\rho = 1.666 \text{ g } /cm^3$$

The density of the tin sheet is 1.67 g /cm^3. (From this result, can we check this tin sheet will float or not? We already known that the density of water is 1 g /cm^3. The density of tin sheet is greater than density of water. [(1.67g/cm^3) > (1 g /cm^3)]. So, this tin sheet can't float. It will sink.)

Step-2: Make that tin sheet into a box.

When we make a box from that tin sheet, particular amount of air is naturally locked with inside the box. So, two different medium is there now (One is tin box, another one is air). **Xaviour's law of floatation** says that, "At not exit condition, when the air is sealed within an object, the density of air along with the density of object reaches the average density". From this law, we can calculate the average density of that tin box.

$$\text{Density of floating object} = \frac{\text{Sum of the density of medium}}{\text{Number of medium}}$$

$$\text{i.e.., Dfo} = \frac{\Sigma \text{Dm}}{\text{N}}$$

Two medium is there, tin and air. We already find that the density of tin sheet is 1.67 g/cm^3 and the density of air is 0.01225 g/cm^3. Hence, the sum of the density of medium is,

$$\text{Dfo} = \frac{1.67\text{g}/cm^3 + 0.012\text{g}/cm^3}{2}$$

Number "2" represents the number of medium (N).

$$\text{Dfo} = \frac{1.682}{2}$$

$$\text{Dfo} = 0.841 \text{ g}/cm^3$$

From this result, the average density of floating tin box is 0.841 g/cm^3. According to xaviour's law of floatation "If this average density is less than the density of fluid, that object will float (Dfo < Df)". By this statement, 0.841g/cm^3<1g/cm^3. It will float because the average density of floating object is less than the density of fluid (Water).

Step-3: What will happen, if we fill the tin box with water?

We known that the density of water is 1g/cm^3 and the density of tin sheet is 1.67 g/cm^3. Substitute these values in Xaviour's law of floatation.

$$Dfo = \frac{\Sigma Dm}{N}$$

$$Dfo = \frac{1.67 g/cm^3 + 1 g/cm^3}{2}$$

$$Dfo = \frac{2.67}{2}$$

$$Dfo = 1.335 \text{ g}/cm^3$$

So, if we fill the box with water instead of air, it will sink because, the average density of floating object is higher than the density of water. (1.335 g/cm^3 > 1g/cm^3).

APPLICATION FOR XAVIOUR'S LAWS OF FLOATATION:-

- Xaviour's law of floatation is applied in all vessels which travel by waterways that include ships, submarines and ferry boats. Ship is like an iron bowl floating in water, although iron is denser than water the bowl does not sink. Being hollow it contains air causing its average density to be lower than that of water. Sand can be poured in the bowl but it will keep floating, in excess mass of sand the bowl will sink, in ship we call it overloading. Ships are made of metals such as steel or aluminium alloy which are denser than water, so to make it be able to float it is hollow and filled with air making the average density lower than density of water even when it is loaded with her cargo. Ship travels in different densities of water, sea water or fresh water, (hot or cold) So by changing water ways ship can displace more or less water in which it floats that means it may gain or lose up thrust. If the up thrust becomes lower than its own weight the ship sinks. So for safety loading of the ship under different sea conditions plimsol lines are provided. Plimsol lines are lines which show maximum height of the ship that should be under water. Plimsol lines are also referred as plimsol marks.

- In transportation by air ways. It is also applied in some vessels which travel by air ways such as hot air balloon and air ship. Hot air balloon: To watch animals at Serengeti helicopters is noisy it would scare the animals, plane is faster it would pass without clear vision but hot air balloon will do. Hot air balloon consist of three parts, the balloon, the burner and the basket. The burner uses the propane gas to heat up air in the balloon as the air in the balloon gets hot it expands its density becomes lower than the surrounding air so it raise. To get the balloon down the pilot can open a parachute valve at the top of the balloon causing cold air to enter in the balloon and decrease the temperature inside the balloon so, the density also the pilot can let the air inside the balloon to cool itself by burning less fuel. In this setup, density of hot air balloon along with density of propane gas reaches the average density. So, it can float.

CONCLUSION:

Floatation is always depends on the density of medium. By using my Xaviour's law of floatation, we can make any non floatable or heavy weighted objects to float, by adding particular amount of lower density medium (like air) with that. Xaviour's law of floatation gives a new way to find out the average density (new concept) of floating object. So, if we use this law in our physical applications of day to day life, we can understand the secret of nature in floatation.