

**Selina Solutions For Class 9 Physics**  
**Chapter 5 – Upthrust in Fluids, Archimedes' Principle and Floatation**

Exercise-5(C)

1. State the principle of floatation.

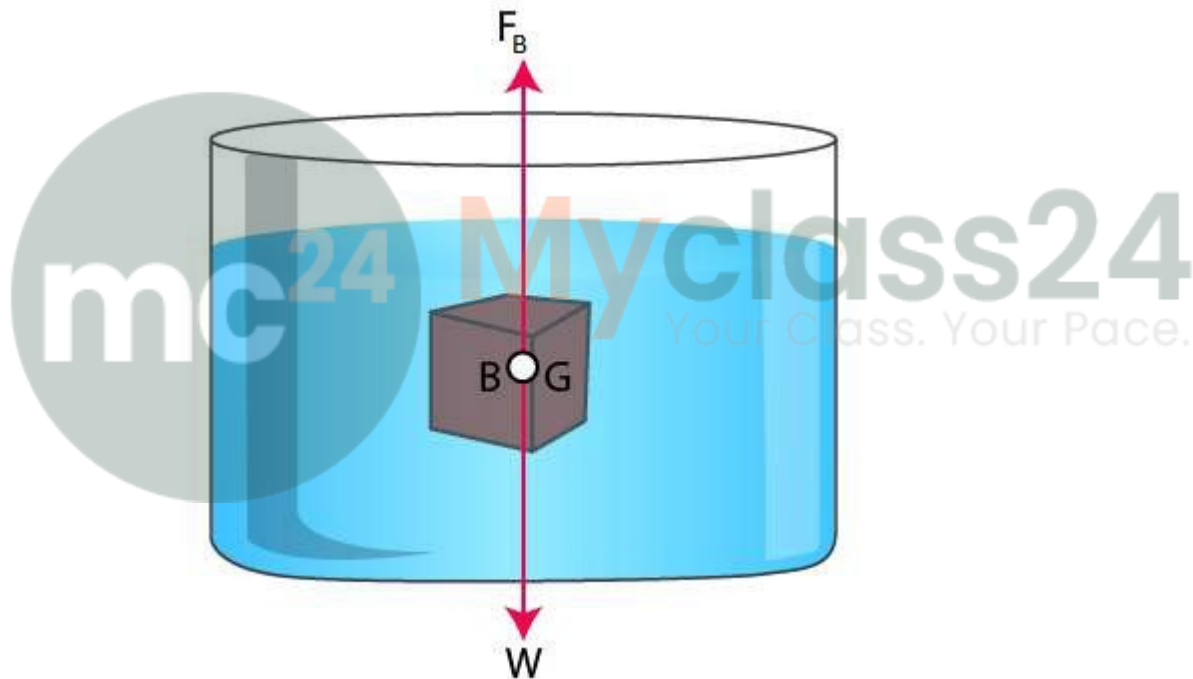
**Solution:**

The principle of floatation states that the weight of a floating body is equal to the weight of the liquid displaced by its submerged part.

2. A body is held immersed in a liquid. (i) Name the two forces acting on body and draw a diagram to show these forces. (ii) State how do the magnitudes of two forces mentioned in part (i) determine whether the body will float or sink in liquid when it is released. (iii) What is the net force on body if it (a) sinks, (b) floats?

**Solution:**

- (i) The two forces that act on the body are:  
Downward direction – weight of the body  
Upward direction – upthrust of the liquid



- (ii) Magnitude of the forces acting on the body can determine whether the body will sink or float.  
The body will sink if the weight of the body is greater than the upthrust acting on it whereas the body will float if the weight of the body is equivalent to or lesser than the upthrust acting on it.
- (iii) (a) The net force acting on the body when it sinks is the weight of the body itself.  
(b) The net force acting on the body when it floats is the upthrust due to the liquid.
3. When a piece of wood is suspended from the hook of a spring balance, it reads 70 gf. The wood is now lowered into water. What reading do you expect on the scale of spring balance?

**Selina Solutions For Class 9 Physics**  
**Chapter 5 – Upthrust in Fluids, Archimedes' Principle and Floatation**

---

[Hint: The piece of wood will float on water and while floating, apparent weight = 0].

**Solution:**

The reading on the scale of the spring balance shows zero. It is zero as the wood floats on the water and when it is floating, the apparent weight is zero.

4. **A solid iron ball of mass 500g is dropped in mercury contained in a beaker, (a) Will the ball float or sink? Give reason. (b) What will be the apparent weight of ball? Give reason.**

**Solution:**

- (a) The ball will float. It is because the density of iron ball is lesser than the density of mercury.  
(b) The apparent weight of the ball is zero. It is because, while floating, upthrust will be equal to the weight.

5. **How does the density  $\rho_s$  of a substance determine whether a solid piece of that substance will float or sink in a given liquid of density  $\rho_L$ ?**

**Solution:**

The body will float if  $\rho_s \leq \rho_L$  and it will sink if  $\rho_s > \rho_L$

6. **Explain why an iron nail floats on mercury, but it sinks in water.**

[Hint: Density of iron is less than that of mercury, but more than that of water]

**Solution:**

Iron nail floats on mercury because the density of iron is lesser than that of mercury  
Iron nail sinks in water because the density of iron is more than the density of water.

7. **A body floats in a liquid with a part of it submerged inside liquid. Is the weight of floating body greater than, equal to or less than upthrust?**

**Solution:**

If the body is floating on the liquid, the weight of the floating body is equal to the upthrust.

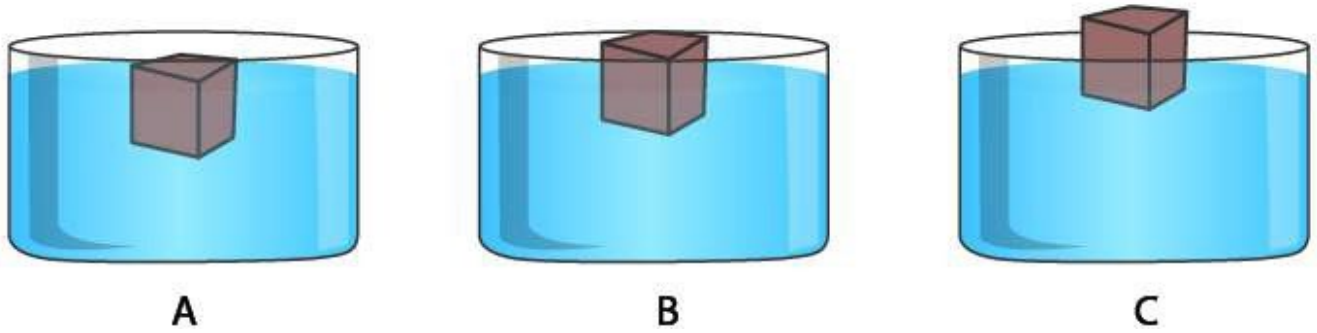
8. **A homogenous block floats on water (a) partly immersed (b) completely immersed. In each case state the position of centre of buoyancy B with respect to the centre of gravity G of the block.**

**Solution:**

- (a) Partly immersed - centre of buoyancy B will lie vertically below centre of gravity, G.  
(b) Completely immersed - centre of buoyancy B will coincide with centre of gravity, G.

9. **Figure shows the same block of wood floating in three different liquids A,B and C of densities  $\rho_1$ ,  $\rho_2$ , and  $\rho_3$  respectively. Which of the liquid has the highest density? Give reason for your answer.**

**Selina Solutions For Class 9 Physics**  
**Chapter 5 – Upthrust in Fluids, Archimedes' Principle and Floatation**

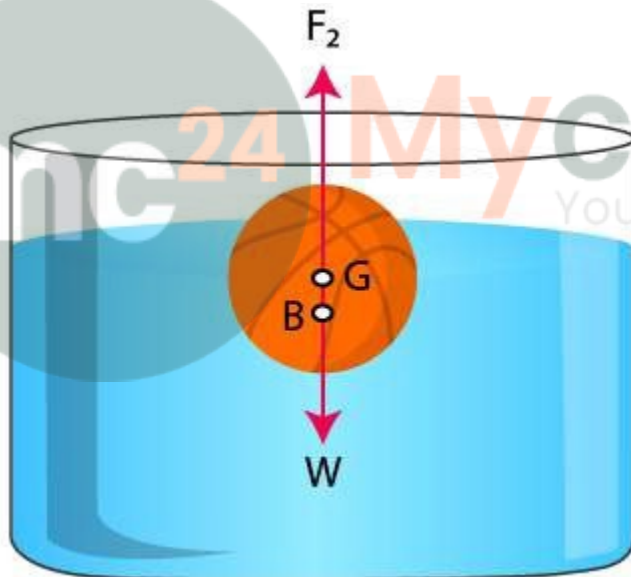


**Solution:**

The upthrust on the body by each liquid is the same and it is equivalent to the weight of body.  
But upthrust = volume submerged  $\times \rho_L \times g$ .  
For liquid C, since volume submerged is least, so density  $\rho_3$  must be maximum.

**10. Draw a diagram to show the forces acting on a body floating in water with its some part submerged. Name the forces and show their points of application. How is the weight of water displaced by the floating body related to the weight of the body itself?**

**Solution:**



The forces acting on the body are:

- Upthrust due to water acting upwards
- Weight of the body acting downwards

The weight of the water displaced by the floating body is equivalent to the weight of the body.

**11. What is center of buoyancy? State its position for a floating body with respect to the centre of gravity of body.**

**Solution:**

Centre of buoyancy is the point through which the resultant of the buoyancy forces act on an immersed body. It coincides with the centre of gravity of the liquid that is displaced if the body is fully immersed.

**Selina Solutions For Class 9 Physics**  
**Chapter 5 – Upthrust in Fluids, Archimedes' Principle and Floatation**

In case of a floating body, the centre of buoyancy is at the centre of gravity of the immersed part of a floating body in the liquid, and lies vertically below the centre of gravity of the whole body.

- 12. A balloon filled with helium gas floats in a big closed jar which is connected to an evacuating pump. What will be your observation, if air from jar is pumped out? Explain your answer.**

**Solution:**

The balloon will sink.

The density of air in the jar decreases as the air is pumped out from the jar. Hence the upthrust on the balloon decreases. The balloon sinks as the weight of the balloon surpasses the upthrust acting on it.

- 13. A block of wood is so loaded that it just floats in water at room temperature. What change will occur in the state of floatation, if**

**(a) Some salt is added to water,**

**(b) Water is heated?**

**Solution:**

(a) It floats with some part outside water.

The density of water increases when salt is added to water, so the upthrust on the block of wood increases and therefore, the block rises up till the weight of salty water displaced by the submerged part of the block becomes equal to the weight of the block.

(b) It sinks.

The density of water decreases on heating, hence the upthrust on the block decreases and the weight of the block exceeds the upthrust as a result of which it sinks.

- 14. A body of volume  $V$  and density  $\rho_s$ , floats with volume  $v$  inside a liquid of density  $\rho_L$ . Show**

**that  $\frac{v}{V} = \frac{\rho_s}{\rho_L}$ .**

**Solution:**

To prove:  $\frac{v}{V} = \frac{\rho_s}{\rho_L}$

Consider :

$V$  to be the volume of the body having density  $\rho_s$

' $v$ ' to be the volume of the body when immersed in a liquid having density  $\rho_L$

The weight of the body can be given by:

$$W = \text{volume of the body} \times \text{density of the body} \times g \\ = V \rho_s g$$

Upthrust or the weight of the liquid displaced by the body is given by:

$$F_B = \text{volume of the liquid displaced} \times \text{density of the liquid} \times g \\ = v \rho_L g$$

We know that for floatation,  $F_B = W$

$$\Rightarrow V \rho_s g = v \rho_L g$$

$$\Rightarrow \frac{v}{V} = \frac{\rho_s}{\rho_L}$$

Hence proved.

**Selina Solutions For Class 9 Physics**  
**Chapter 5 – Upthrust in Fluids, Archimedes' Principle and Floatation**

---

**15. Two identical pieces, one of ice (Density= $900 \text{ kg m}^{-3}$ ) and other of wood (density= $300 \text{ kg m}^{-3}$ ) float on water.**

- (a) Which of the two will have more volume submerged inside water?**  
**(b) Which of the two will experience more upthrust due to water?**

**Solution:**

- (a) Out of the two, ice has more volume submerged inside water  
(b) Out of the two, ice will experience more upthrust due to water

**16. Why is floating ice less submerged in brine than in water?**

**Solution:**

Floating ice is less submerged in brine than in water because the density of brine is more than the density of water.

**17. A man first swims in sea water and then in river water.**

- (i) Compare the weights of sea water and river water displaced by him.**  
**(ii) Where does he find it easier to swim and why?**

**Solution:**

- (i) The weight of the water displaced is equal to the weight of the man in both cases, when he swims in sea water and in river water, hence the comparison yields 1:1.  
(ii) The man will find it easier to swim in sea water as the density of sea water is more than that of the river water. Therefore, his weight is balanced in sea water with lesser part of his immersed inside it.

**18. An iron nail sinks in water while an iron ship floats on water. Explain the reason.**

**Solution:**

It is because the density of iron is more than the density of water. Hence the weight of the nail is comparatively greater than the upthrust that acts on water.

Ships are made of iron yet they do not sink as ships are hollow and the empty space in it contains air making the average density lesser than that of water. Consequently, even with a smaller portion of ship immersed in water, the weight of water displaced by the immersed part of the ship becomes equivalent to the net weight of the ship causing it to float.

**19. What can you say about the average density of a ship floating on water in relation to the density of water?**

**Solution:**

The relation is that the average density of a ship floating on water is lesser than the density of water.

**20. A piece of ice floating in a glass of water melts, but the level of water in glass does not change. Give reason.**

**[Hint: Ice contracts on melting]**

**Solution:**

Ice contracts by the volume equivalent to the volume of ice pieces over the surface of water when floating pieces of ice melt into water. Consequently, the water level remains unchanged when floating ice melts on it.

**Selina Solutions For Class 9 Physics**  
**Chapter 5 – Upthrust in Fluids, Archimedes' Principle and Floatation**

- 21. A buoy is held inside water contained in a vessel by tying it with a thread to the base of the vessel. Name the three forces that keep the buoy in equilibrium and state the direction in which each force acts.**

**Solution:**

The three forces and the direction in which they act are as follows:

| <b>Name of the force</b>  | <b>Direction in which they act</b> |
|---------------------------|------------------------------------|
| Upthrust of water on buoy | Vertically upwards                 |
| Weight of the buoy        | Vertically downwards               |
| Tension in thread         | Vertically downwards               |

- 22. A loaded cargo ship sails from sea water to river water. State and explain your observation.**

**Solution:**

The observation is as follows:

The cargo ship dips into water as it advances from sea water to river water.

Explanation: Density of sea water is more than that of river water. Consequently, as per the law of floatation, in order to balance the weight of the ship, more volume of water is required for the river water having lower density to displace it.

- 23. Explain the following:**

- (a) Icebergs floating in sea are dangerous for ships.
- (b) An egg sinks in fresh water, but floats in a strong salt solution
- (c) A toy balloon filled with hydrogen rises to the ceiling, but if filled with carbon dioxide sinks to the floor
- (d) As a ship in harbor is being unloaded, it slowly rises higher in water
- (e) A balloon filled with hydrogen rises to a certain height and then stops rising further.
- (f) A ship submerges more as it sails from sea water to river water.

**Solution:**

- (a) Icebergs being lighter than water, float on it with almost 90% of it submerged in water and merely some part appearing outside the surface of water. As the portion of iceberg in water surface is dependent on the density of sea water, it becomes challenging for the helmsman to estimate the size of the iceberg. Thus, an iceberg can be very dangerous for a ship as it may collide with the ship and cause damage.
- (b) As the density of strong salt solution is denser than fresh water, it exerts more upthrust on the egg that balances the weight of the egg hence the egg sinks in fresh water but floats on a strong salt solution.
- (c) Density of carbon dioxide is much more than the density of hydrogen, hence when a balloon is filled with hydrogen, the weight of the air displaced by an inflated balloon or the upthrust tends to become greater than the weight of the gas balloon that is filled causing it to rise. But when the balloon is filled with carbon dioxide, the balloon weighs more than the upthrust offered by air causing it to sink to the floor.
- (d) The weight of the ship decreases as it is unloaded at the harbor because of which less water is displaced causing the hull of the ship to rise in water until the weight of the water displaced balances the weight of the unloaded ship
- (e) The density of air decreases as the altitude decreases. Hence, as the balloon eventually goes up in the air, the weight of the air displaced decreases. The balloon keeps rising until the

**Selina Solutions For Class 9 Physics**  
**Chapter 5 – Upthrust in Fluids, Archimedes' Principle and Floatation**

---

upthrust surpasses its own weight and stops rising once the upthrust is equivalent to its weight.

- (f) Density of sea water is more than that of river water. Consequently, as per the law of floatation, in order to balance the weight of the ship, more volume of water is required for the river water having lower density to displace it.

**Multiple choice type:**

1. For a floating body, its weight  $W$  and upthrust  $F_B$  on it are related as:

- (a)  $W > F_B$   
(b)  $W < F_B$   
(c)  $W = F_B$   
(d) Nothing can be said

**Solution:**

- (c)  $W = F_B$

The apparent weight of a floating body is zero.

2. A body of weight  $W$  is floating in a liquid. Its apparent weight will be:

- (a) Equal to  $W$   
(b) Less than  $W$   
(c) Greater than  $W$   
(d) Zero

**Solution:**

- (d) Zero

If weight  $W$  and upthrust acting on a body are equal, the body floats and hence its apparent weight will be zero.

3. A body floats in a liquid A of density  $\rho_1$  with a part of it submerged inside liquid while in liquid B of density  $\rho_2$  totally submerged inside liquid. The densities  $\rho_1$  and  $\rho_2$  are related as:

- (a)  $\rho_1 = \rho_2$   
(b)  $\rho_1 < \rho_2$   
(c)  $\rho_1 > \rho_2$   
(d) nothing can be said

**Solution:**

- (c)  $\rho_1 > \rho_2$

Density of liquid A is greater than the density of liquid B as the body is partially immersed in liquid A while fully immersed in liquid B.

**Numericals:**

1. A rubber ball floats on water with its  $1/3^{\text{rd}}$  volume outside water. What is the density of rubber?

**Solution:**

To find the density of rubber

Consider the volume of the ball to be  $V$

**Selina Solutions For Class 9 Physics**  
**Chapter 5 – Upthrust in Fluids, Archimedes' Principle and Floatation**

As per given data, volume of the ball above the water surface =  $(1/3)V$

$$\Rightarrow \text{Volume of the ball immersed in water} = V - 1/3V = 2/3V$$

We know from the principle of floatation:

$$\frac{\text{Volume of rubber ball immersed}}{\text{Net volume of the ball}} = \frac{\text{density of rubber}}{\text{density of water}}$$

$$\Rightarrow \frac{2}{3} = \frac{\text{density of rubber}}{1000}$$

$$\Rightarrow \text{Density of rubber} = 1000 \times \frac{2}{3} = 667 \text{ kg m}^3$$

**2. A block of wood of mass 24kg floats on water. The volume of wood is 0.032 m<sup>3</sup>. Find:**

**(a) The volume of block below the surface of water,**

**(b) The density of wood.**

**(density of water = 1000 kg m<sup>-3</sup>)**

**Solution:**

(a) Given:

Mass of the wood block = 24kg

Volume of the wood block = 0.032 m<sup>3</sup>

Upthrust = volume of the block below the water surface x density of liquid x g

Upthrust for floatation is equivalent to the weight of the body i.e., 24kgf

$$\Rightarrow 24\text{kgf} = v \times 1000 \times g$$

$$\Rightarrow v = 24/1000 = 0.024 \text{ m}^3$$

(b) To find density of wood

As per the law of floatation,

$$\frac{\text{Volume of submerged block}}{\text{Net volume of the block}} = \frac{\text{density of wood}}{\text{density of water}}$$

$$\Rightarrow \frac{0.024}{0.032} = \frac{\text{density of wood}}{1000}$$

$$\Rightarrow \text{density of wood} = 750 \text{ kg m}^{-3} = 7.5 \times 10^2 \text{ kg m}^{-3}$$

**3. A wooden cube of side 10cm has mass 700g. What part of it remains above the water surface while floating vertically on the water surface?**

**Solution:**

Given:

Side of the wooden cube = 10cm

Volume of the cube = 10cm x 10cm x 10cm = 10<sup>3</sup> cm<sup>3</sup>

Mass of the wooden cube = 700g

As per the law of floatation,

$$\frac{\text{Volume of submerged cube (v)}}{\text{Net volume of the cube (V)}} = \frac{\text{density of wood}}{\text{density of water}}$$

$$= \frac{v}{10^3} = \frac{700 \times 10^{-3}}{1}$$

$$\Rightarrow \text{Volume of the submerged cube, } v = 1000 \times 700 \times 10^{-3} = 700 \text{ cm}^3$$

$$\Rightarrow \text{Volume of the cube over the surface of water} = V - v \Rightarrow 1000 - 700 = 300 \text{ cm}^3$$

$\therefore$  300 cm<sup>3</sup> of the wooden cube remains above the water surface

**Selina Solutions For Class 9 Physics**  
**Chapter 5 – Upthrust in Fluids, Archimedes' Principle and Floatation**

4. A piece of wax floats on brine. What fractions of its volume is immersed?  
Density of wax =  $0.95 \text{ g cm}^{-3}$ , density of brine =  $1.1 \text{ g cm}^{-3}$

**Solution:**

Given:

Density of wax =  $0.95 \text{ g cm}^{-3}$

Density of brine =  $1.1 \text{ g cm}^{-3}$

Consider 'V' to be the net volume of the wax and 'v' be the volume of the submerged part

As per the law of floatation,  $\frac{v}{V} = \frac{\text{Density of wax}}{\text{density of brine}}$

$$\Rightarrow \frac{v}{V} = \frac{0.95}{1.1} = 0.86$$
$$\Rightarrow v = 0.86V$$

Hence, the piece of wax floats with  $0.86^{\text{th}}$  part of its volume over the brine surface.

5. If the density of ice is  $0.9 \text{ g cm}^{-3}$ , what portion of an iceberg will remain below the surface of water in a sea? (Density of sea water =  $1.1 \text{ g cm}^{-3}$ )

**Solution:**

Given:

Density of ice =  $0.9 \text{ g cm}^{-3}$

Density of sea water =  $1.1 \text{ g cm}^{-3}$

Consider 'V' to be the net volume of the iceberg and 'v' to be the volume of the submerged part

As per the law of floatation,  $\frac{v}{V} = \frac{\text{Density of ice}}{\text{density of sea water}}$

$$\Rightarrow \frac{v}{V} = \frac{0.9}{1.1}$$
$$\Rightarrow v = \frac{9}{11}V$$

Ice floats on the surface of sea water with  $9/11^{\text{th}}$  of its portion over the sea surface.

6. A piece of wood of uniform cross section and height 15cm floats vertically with its height 10cm in water and 12cm in spirit. Find the density of (i) wood and (ii) spirit.

**Solution:**

Given:

Height of the wood = 15cm

Height of the wood immersed in water = 10cm

Height of the wood immersed in spirit = 12cm

As the block of wood is of uniform cross-sectional area, the height of the block is proportional to the volume

Let the density of wood be  $\rho_w \text{ g cm}^{-3}$

Let the density of spirit be  $\rho_s \text{ g cm}^{-3}$

As per the law of floatation,  $\frac{v}{V} = \frac{\text{Density of wood}}{\text{density of water}}$

$$\Rightarrow \frac{10}{15} = \frac{\text{Density of wood}}{1} \quad [\text{density of water} = 1 \text{ g cm}^{-3}]$$

$$\Rightarrow \text{Density of wood} = 0.667 \text{ g cm}^{-3}$$

**Selina Solutions For Class 9 Physics**  
**Chapter 5 – Upthrust in Fluids, Archimedes' Principle and Floatation**

As per the law of floatation,  $\frac{v}{V} = \frac{\text{Density of wood}}{\text{density of spirit}}$

$$\Rightarrow \frac{12}{10} = \frac{0.667}{\text{density of spirit}}$$

$$\Rightarrow \rho_s = (12/10) \times 0.667 = 0.83 \text{ g cm}^{-3}$$

7. A wooden block floats in water with two-third of its volume submerged. (a) Calculate the density of wood. (b) When the same block is placed on oil, three-quarter of its volume is immersed in oil. Calculate the density of oil.

**Solution:**

Volume of the block immersed in water ( $v$ ) =  $2/3$  x net volume ( $V$ )

Volume of the block immersed in oil ( $v$ ) =  $3/4$  x total volume ( $V$ )

Let density of wood =  $\rho_w \text{ g cm}^{-3}$

Let density of oil =  $\rho_o \text{ g cm}^{-3}$

As per the law of floatation;  $\frac{v}{V} = \frac{\text{Density of wood}}{\text{density of water}}$

$$\Rightarrow \frac{2}{3} = \frac{\text{density of wood}}{1000}$$

$$\Rightarrow \text{Density of wood} = 1000 \times 2/3 = 667 \text{ kg m}^{-3}$$

As per the law of floatation,  $\frac{v}{V} = \frac{\text{Density of wood}}{\text{density of oil}}$

$$\Rightarrow \frac{3}{4} = \frac{667}{\text{density of oil}}$$

$$\Rightarrow \text{density of oil} = 889.3 \text{ kg m}^{-3}$$

8. The density of ice is  $0.92 \text{ g cm}^{-3}$  and that of sea water is  $1.025 \text{ g cm}^{-3}$ . Find the total volume of an ice berg which floats with its volume  $800 \text{ cm}^3$  above water.

**Solution:**

Given:

Density of ice =  $0.92 \text{ g cm}^{-3}$

Density of sea water =  $1.025 \text{ g cm}^{-3}$

Volume of the ice berg above water =  $800 \text{ cm}^3$

Let 'v' be the volume of iceberg immersed in water

As per the law of floatation;  $\frac{v}{V} = \frac{\text{Density of ice}}{\text{density of sea water}}$

$$\Rightarrow \frac{v}{V} = \frac{0.92}{1.025} = 0.8976$$

$$\Rightarrow v = 0.8976V$$

Volume of the iceberg over the surface of sea water is given by:

$$V(1-0.8976) = 800$$

$$\Rightarrow V = 800/(1-0.8976)$$

$$\Rightarrow V = 7812.5 \text{ cm}^3$$

**Selina Solutions For Class 9 Physics**  
**Chapter 5 – Upthrust in Fluids, Archimedes' Principle and Floatation**

9. A weather forecasting plastic balloon of volume  $15\text{m}^3$  contains hydrogen of density  $0.09\text{kg m}^{-3}$ . The volume of an equipment carried by the balloon is negligible compared to its own volume. The mass of empty balloon alone is  $7.15\text{kg}$ . The balloon is floating in air of density  $1.3\text{ kg m}^{-3}$ . Calculate : (i) the mass of hydrogen in the balloon, (ii) the mass of hydrogen and balloon, (iii) the total mass of hydrogen, balloon and equipment if the mass of equipment is  $x\text{ kg}$ , (iv) the mass of air displaced by balloon and (v) the mass of equipment using the law of floatation.

**Solution:**

Given:

Mass of the unfilled balloon =  $7.15\text{kg}$

Volume of the plastic balloon =  $15\text{m}^3$

Density of air =  $1.3\text{ kg m}^{-3}$

Density of hydrogen =  $0.09\text{ kg m}^{-3}$

(i) To find the mass of hydrogen in the balloon

Mass of hydrogen in the balloon = volume of balloon  $\times$  density of hydrogen

$$\Rightarrow 15 \times 0.09 = 1.35\text{kg}$$

(ii) To find the mass of hydrogen and balloon

Mass of hydrogen and balloon = mass of hydrogen in the balloon + mass of unfilled balloon

$$= 7.15 + 1.35 = 8.5\text{kg}$$

(iii) To find the total mass of hydrogen, balloon and equipment

Given: mass of equipment is ' $x$ ' kg

Total mass =  $(8.5 + x)\text{kg}$

(iv) To find the weight of the air displaced by the balloon

Weight of the air displaced = upthrust

$$\Rightarrow \text{Volume of the balloon} \times \text{density of the air} \times g$$

Mass of the air displaced = volume of the balloon  $\times$  density of the air

$$= 15 \times 1.3 = 19.5\text{kg}$$

(v) To find the mass of the equipment using the law of floatation

As per the law of floatation;

Mass of the air displaced = total mass of hydrogen, balloon and equipment

$$19.5 = 8.5 + x$$

The mass of the equipment is  $11\text{kg}$