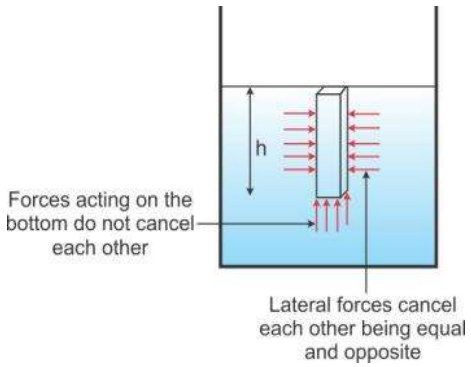
5	Upthrust in Fluid, Archimedes Principle and Floatation	Book : Selina

Exercise A

1. **What do you understand by term upthrust as fluid? Describe experiment to show its existence.**
   When a body is immersed in a liquid, the liquid exerts an upward force of the body. This force is called the upthrust or buoyant force.
   Experiment:
   Take an empty tin can. Close its mouth with an airtight stopper. Put it in a tub filled with water. It floats with a large part of it above the surface of water and only a small part of it below the surface of water. Push the can into the water. You feel an upward force and you find it difficult to push the can further into the water. It is also noticed that as the can is pushed more and more into the water larger and larger force needed to push the can further into the water, till it is completely immersed. When the can is fully inside water, a definite amount of force is still needed to keep it at rest in that position. Now if the can is released in this position, it is noticed that the can bounces back to the surface and starts floating again.
2. **In what direction and at what point does the buoyant force on a body due to a liquid, act?**
   Ans, Upwards, at the centre of buoyancy
3. **What is meant by the term buoyancy?**
   The property of liquid to exert an upward force on a body immersed in it, is called buoyancy,
4. **Define upthrust and state its S.I. unit.**
   When a body is partially or wholly immersed in a liquid, an upward force acts on it. This upward force is known as upthrust or buoyant. Its S.I. unit is Newton.
5. **What is the cause of upthrust? At which point can it be considered to act?**
   A liquid contained in a vessel exerts pressure at all points and in all directions. The pressure at a point in a liquid is the same in all directions - upwards, downwards and sideways. It increases with the depth inside the liquid.



When a body is immersed in a liquid, the thrusts acting on the side walls of the body are neutralized as they are equal in magnitude and opposite in direction. However, the magnitudes of pressure on the upper and lower faces are not equal. The difference in pressure on the upper and lower faces cause a net upward force (= pressure x area) or upthrust on the body.

It acts at the centre of buoyancy.

6. **Why is a force needed to keep a block of cork inside water?**
   Upthrust on block due to water is more than its weight
7. **A piece of wood left under water come to the surface. Explain the reason.**
   Because upthrust on piece of wood is more than its weight.
8. **Describe an experiment to show that a body immersed in a liquid appears lighter than it really is.**
   Take an empty bucket and tie a long rope to it. Immerse the bucket in the water of the well keeping one end of the rope in your hand. Lift the bucket when full of water. You will notice that it is easy to lift the bucket as long as it is inside water. But when it starts coming out of the water surface, it appears to become heavy and it becomes difficult to lift it i.e. much more force is needed now to lift it. This experiment shows that the bucket of water appears lighter than its actual weight when it is immersed in water.
9. **Will a body weigh more in air or in vacuum when weighed with a spring balance? Give a reason for your answer.**
   Weight is more in vacuum because of absence of upthrust of air.
10. **A metal solid cylinder tied to a thread is hanging from the hook of a spring balance. The cylinder is gradually immersed into the water contained in a jar. What changes do you expect in readings of the spring "balance? Explain your answer.**
    A metal solid cylinder will weigh slightly less in water than in air due to the upthrust of water on a metal solid cylinder.
11. **A body dipped into a liquid experiences an upthrust. State two factors on which the upthrust on the body depends.**
    The upthrust due to liquid on a body depends on the following two factors :
    (1) the volume of the body submerged in the liquid (or fluid), and
    (2) the density of the liquid (or fluid) in which the body is submerged.
12. **How is the upthrust related to the volume of the body submerged in a liquid?**
    As we know that when a body is immersed in a liquid, it occupies the space, which was earlier occupied by the liquid i.e., it displaces the liquid. The volume of the liquid displaced by the body is equal to the volume of the submerged part of the body and due to this displacement of liquid, the body experiences an upthrust equal to the weight of the liquid displaced by the body
13. **A bunch of feathers and a stone of the same mass all at different rates in air. Which falls faster and why? How will your observation change if they are allowed to fall together in vacuum?**
    If a bunch of feathers and a stone of same mass are allowed to fall in air, the stone falls faster than the bunch of feathers, me reason is that the upthrust due to air on stone will be less than that on the bunch of feathers because the volume of stone is less than that, of the bunch of feathers of same mass. But in vacuum, there will be no upthrust, so both the bunch of feathers and stone will fall together.

14. A body experiences an upthrust F_1 in river water and the same body experiences the upthrust F_2 in sea water. Which is more F_1 or F_2? Give reason.

$F_2 > F_1$, Reason: Sea water is more dense than the river water.

15. A small block of wood is completely immersed in (i) water, (ii) glycerine and then released. In each case, What do you observe? Explain the difference in your observation in the two cases.

Observation: Volume of a block of wood immersed in glycerine is smaller as compared to the volume of block immersed in water.

Explanation: Density of glycerine is more than that of water. Hence, glycerine exerts more upthrust on the block of wood than water, causing it to float in glycerine with a smaller volume.

16. A body of volume V and density ρ is completely immersed in a liquid of density ρ_L. If g is the acceleration due to gravity, write expressions for the following :

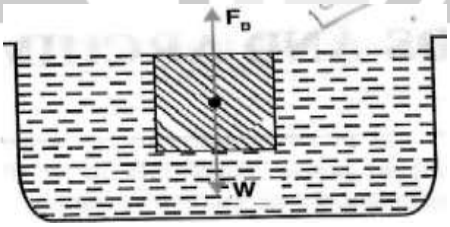
(i) the weight of the body, ($V\rho g$)

(ii) the upthrust on the body, ($V \rho_L g$)

(iii) the apparent weight of the body in liquid. ($V (\rho - \rho_L)$)

(iv) the loss in weight of the body. ($V \rho_L g$)

17. A body is held completely immersed inside a liquid experiences two forces: F1 the force due to gravity and F2 the buoyant force. Draw a diagram showing the direction of these forces acting on the body and state condition when the body will float or sink.



The buoyant force F_B can. be greater than, equal to or less than the weight W of the given body depending upon the density of the fluid. This fact will determine whether the body will float or sink in the fluid. If $F_B > W$ or $F_B = W$, the body will float. If $F_B > W$, the body will float with only that much part of it inside the liquid, the upthrust due to which becomes equal to the weight of the body. So while floating F_B will be equal to W. For a floating body, net force acting downwards (i.e. apparent weight) is zero. But if $F_B < W$, the body will sink. The net force on the body acting downwards will be $(W- F_B)$.

18. Complete the following sentences :

(1) Two balls, one of iron and the other of aluminium experience the same upthrust when dipped in water if _____. *(both have equal volume)*

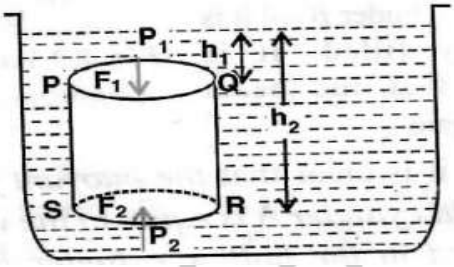
(2) An empty tin container with its mouth closed has an average density equal to that of liquid A. The container is taken 2m below the surface of liquid A and is left there. Then _____.

(container will bounce back to the surface)

(3) A piece of wood is held under water. The upthrust on it will be _____ the weight of the wood piece. *(more than)*

19. Prove that the loss in weight of a body when immersed wholly or partially in a liquid is equal to the buoyant force (or upthrust) and this exists because of difference in the pressures of the liquid exerted on the upper and lower surfaces of the submerged part of the body.

Let us consider a cylindrical body PQRS of cross sectional area A immersed in a liquid of density ρ Let the upper surface PQ of the body be at a depth h1 below the free surface of liquid and the lower surface RS of the body be at a depth h2 below the free surface of liquid (as in figure)



At depth h_1, pressure on the upper surface PQ $(P_1) = h_1 \rho g$

So, Downward thrust on the upper surface PQ (F_1) = pressure x area = $h_1 \rho g A$ ----------(i)

At depth h_2, pressure on the upper surface RS $(P_2) = h_2 \rho g$

So, upward thrust on the lower surface RS (F_2) = pressure x area = $h_2 \rho g A$ ----------(ii)

The horizontal thrusts at various points on the vertical sides of the cylinder get balanced because the liquid pressure is same at all points at the same depth.

From above eqns. (i) and (ii), it is clear that $F_2 > F_1$ because $h_2 > h_1$ and therefore, the cylinder will experience a net upward force.

Resultant upward thrust (or buoyant force) on the body

$F_B = F_2 - F_1$

$F_B = h_2 \rho g A - h_1 \rho g A$

$F_B = A (h_2 - h_1) \rho g$

But $A (h_2 - h_1) = V$, the volume of cylinder submerged in liquid

So, Upthrust $F_B = V \rho g$

Since a solid when immersed in a liquid, displaces liquid equal to the volume of its submerged part, therefore,

$V \rho g$ = Volume of solid immersed x density of liquid x acceleration due to gravity
= Volume of liquid displaced x density of liquid x acceleration due to gravity
= mass of liquid displaced x acceleration due to gravity
= Weight of the liquid displaced by the submerged part of the body.

20. A sphere of iron and another of wood of the same radius are held under water. Compare the upthrust on the two spheres. [Hint : Both will have equal volumes inside water.]

1 : 1

21. A sphere of iron and another of wood, both of same radius are placed on the surface of water. State which of the two will sink ? Give reason to your answer.

Ans. Sphere of iron will sink.

Reason : $\rho_{iron} > \rho_{water}$, so weight of iron sphere will be more than upthrust on it due to water. But $\rho_{wood} < \rho_{water}$ so sphere of wood will float with its that much volume submerged in side water by which upthrust on it due to water balances its weight.

22. How does the density of material of a body determine whether it will float or sink in water?

Take few solid bodies of different materials and place them on the surface of water and observe which of these float. It will be observed that if the density of the material of the body is equal to or less than the density of water (i.e., $\rho = \rho_w$, or $\rho < \rho_w$), it floats, implying that the upthrust on the body is equal to its own weight (i.e., $F_B = W$), Different bodies float on water with their different volumes inside water. If $\rho = \rho_w$, the body floats with whole of its volume inside water, while if $\rho < \rho w$, the body floats with only that much volume inside water by which the upthrust FB on body balances its weight W. On the other hand, if the density of the material of body is more than the density of the water (i.e.. $\rho > \rho_w$), the body sinks, suggesting that the upthrust due to water on the body is less than its weight (i.e., $F_B < W$). An empty tin can (or iron ship) floats on water because its average density [= mass of can (or ship) divided by its volume] is less than the density of water. Thus, it is concluded that bodies of average density greater than of liquid, sink in it, while bodies of average density equal to or smaller than that of liquid, float on it.

23. A body of density ρ is immersed in a liquid of density ρ_L. State condition when the body will (i) float, (ii) sink, in liquid.

Ans. (i) $\rho <$ or $= \rho_L$, (ii) $\rho > \rho_L$

24. It is easier to lift a heavy stone under water than in air. Explain.

It is easier to lift a heavy stone under water than in air because in water, it experiences an upward buoyant force which balances the actual weight of the stone acting downwards. Thus, due to upthrust there is an apparent loss in the weight of the heavy stone, which makes it lighter in water, and hence easy to lift.

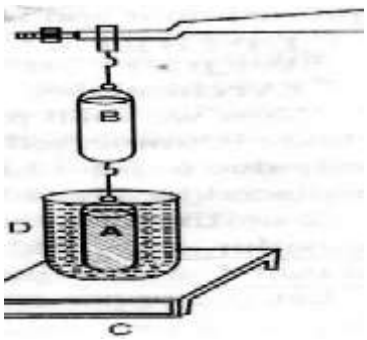
25. State Archimedes' principle.

Archimedes' principle states that when a body is immersed partially or completely in a liquid, it experiences an upthrust, which is equal to the weight of the liquid displaced by it.

26. Describe an experiment to verify the Archimedes' principle.

Archimedes' principle can be verified by following experiments.

Take two cylinders A and B of the same volume. The cylinder A is solid and die cylinder B is hollow. Suspend the two cylinders from the left arm of a physical balance keeping, the solid cylinder A below the hollow cylinder B. Then balance the beam by keeping weights on right arm of the balance. In this situation, both cylinders A and B are in air.



The solid cylinder A is now completely immersed in water contained in a beaker D placed on a bench C as shown in Fig. 7.3. Take care that the cylinder A does not touch the sides and bottom of the beaker. It is observed that the solid cylinder A loses weight i.e., the left arm of the balance rises up. The loss in weight is due to upthrust (or buoyant force) of water on the cylinder A

Now pour water gently in the hollow cylinder B till it is completely filled. It is observed that the beam balances again

Thus, it is clear that the buoyant force acting on the solid cylinder A is equal to the weight of the water filled in the hollow cylinder B. Since the cylinders A and B both have equal volume, so the weight of water in the hollow cylinder B is just equal to the weight of water displaced by the cylinder A. Hence the buoyant force acting on the cylinder A is equal to the weight of water displaced by it. Thus, it verifies the Archimedes' principle,

27. Multiple' choice type :

(1) The upthrust experienced by a body immersed in a liquid is equal to : the weight of the liquid displaced by the body

(2) A body will experience minimum upthrust when it is immersed in : turpentine

(3) The S.I. unit of upthrustis : N

(4) A body of density ρ sinks in a liquid of density ρL. The densities p and ρL are related as: ρ > ρL

Exercise B

1. Define the term density.

The density of a substance is its mass per unit volume.

2. State the (i) C.GS. and (ii) S.I. units of density.

(i) gm cm^{-1}, (ii) kg m^{-1}

3. Express the relationship between the C.G.S. and S.I. unit of density.

1 g cm^{-3} = 1000 kg m^{-3}

4. The density of iron is 7800 kg m^{-3}. What do you understand by this statement?

The mass 1 m^3 of iron is 7800 kg.

5. Write the density of water at 4° C in S.I. unit.

1000 kg m^{-3}

6. How are the (i) mass, (ii) volume, and(iii) density of a metallic piece affected, if at all, with increase in temperature ?

Ans. (i) unchanged, (ii) increases, (iii) decreases.

7. Water is heated from 0°C to 10°C. How does the density of water change with temperature?

On heating from 0°C, the density of water increases up to 4°C and then decreases beyond 4°C.

8. Complete the following sentences.

(1) Mass = _____ x density. (volume)

(2) S.I. unit of density is _____. ($kg\ m^{-3}$,)

(3) Density of water is _____ $kg\ m^{-3}$. (1000)

(4) Density in $kg\ m^{-3}$ = _____ x density in $g\ cm^{-3}$. (10^{-3})

9. What do you understand by the term relative density of a substance?

The relative density (R.D.) of a substance is the ratio of the density of the substance to the density of water at 4°C.

$$\text{R.D.} = \frac{\text{Density of substance } (\rho_s)}{\text{Density of water at 4°C } (\rho_w)}$$

10. What is the unit of relative density?

No unit

11. Differentiate between density and relative density of a substance.

Density	*Relative density*
1. Density of a substance is the mass per unit volume of that substance.	1. Relative density of a substance is the ratio of density of that substance to the density of water at 4°C.
2. It is expressed in $g\ cm^{-3}$ or $kg\ m^{-3}$.	2. It has no unit.

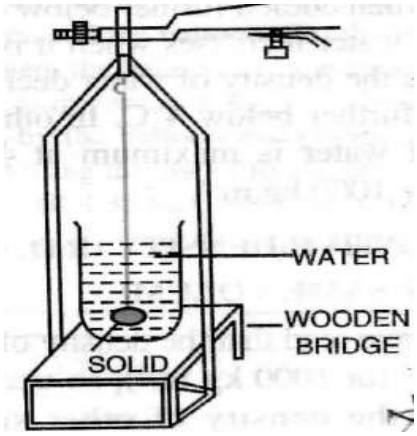
12. With the use of Archimedes' principle, state how you will find the relative density of a solid denser than water. How will you modify your experiment if the solid is soluble in water?

Procedure:

(1) Suspend the given solid with a thread from the hook of the left pan of a physical balance and find its weight

(2) Now place a wooden bridge over the left pan of the balance and place a beaker nearly two-third filled with water on the bridge. Take care that the bridge and beaker do not touch the pan of the balance

(3) Immerse the solid completely in water such that it does not touch the walls and bottom of the beaker and find the weight of the. solid in water



Observation:

Weight of the solid in air – W_1 gf

Weight of the solid in water = W_2 gf

Calculation:

Loss in weight of the solid when immersed in water = $(W_1 - W_2)$ gf

Weight of the solid in water = W_2 gf

$$\text{R.D.} = \frac{\text{Weight of the solid in air}}{\text{Loss in weight of solid in water}}$$

$$= \frac{W_1}{W_1 - W_2}$$

If the solid is soluble in water, we take a liquid instead of water, in which the solid is insoluble and the solid sinks in that liquid. Then

$$\text{R.D.} = \frac{\text{Weight of the solid in air}}{\text{Loss in weight of solid in liquid}} \times \text{R.D. of liquid}$$

13. A body weighs W gf in air and W{ gf when it is completely immersed in water. Find :

(1) Volume of the body,

$(W - W_1)$ cm^3

(2) upthrust on the body

$(W - W_1)$ gf

(3) relative density of material of the body.

$$\frac{W}{W - W_1}$$

14. Describe an experiment, using Archimedes' principle, to find the relative density of a solid (say, cork) which floats on water.

Procedure:

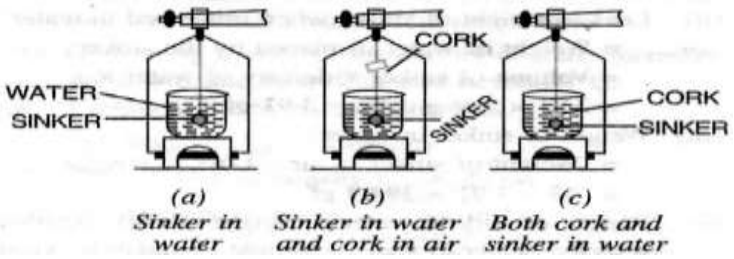
(1) Take a sinker (a piece of metal or stone).

(2) Place a beaker nearly two-third filled with water on a wooden bridge1 kept over the left pan of the physical balance.

(3) Suspend the sinker with a thread from the hook of the left pan of the balance so that it gets completely immersed in water [Fig. (a)]. Find the weight of the sinker in water.

(4) Now tie the given solid (say, a cork) in the middle of the thread and then measure the weight of the given solid in air along with the sinker in water [Fig. (b)].

(5) Next tie the given solid with sinker and immerse both of them completely in water of the beaker and measure the weight of the solid and sinker both in water [Fig. (c)].



(a) Sinker in water *(b) Sinker in water and cork in air* *(c) Both cork and sinker in water*

Observation:

Weight of sinker in water = W_1 gf

Weight of sinker in water and cork in air = W_2 gf

Weight of sinker and cork together in water = W_3 gf

Calculations :

Weight of cork in air = $(W_2 - W_1)$ gf

Weight of cork in water = $(W_3 - W_1)$ gf

Loss in weight of cork in water = Weight of cork in air – Weight of cork in water

= $[(W_2 - W_1) - (W_3 - W_1)]$ gf

= $(W_2 - W_3)$ gf

$$\text{R.D. of cork} = \frac{\text{Weight of cork in air}}{\text{Loss in weight of cork in water}} = \frac{W_2 - W_1}{W_2 - W_3}$$

15. A body weighs W_1gf in air and when immersed in a liquid it weighs W_2gf, while it weights W_3gf on immersing it in water. Find: (i) volume of the body (ii) upthrust due to liquid (iii) relative density of the solid and (iv) relative density of the liquid.

Ans,

(i) Volume of the body = $W_1 - W_3$ cm^3

(ii) Upthrust due to liquid = loss in weight when immersed in liquid = $W_1 - W_2$ gf

Weight of a body in air = W_1gf

Weight of that body in liquid = W_2gf

Weight of that body in water = W_3gf

$$\text{RD of Solid} = \frac{\text{Weight of solid in air}}{\text{Weight in air} - \text{Weight in water}}$$

$$= \frac{W_1}{W_1 - W_3}$$

(iii) Weight of a body in air = W_1gf

Weight of that body in liquid = W_2gf

Weight of that body in water = W_3gf

$$\text{RD of Liquid} = \frac{W_1 - W_2}{W_1 - W_3}$$

16. Multiple choke type ;

(1) Relative density of a substance is expressed by comparing the density of that substance with the density of : water.

(2) The unit of relative density is : no unit.

(3) The density of water is : 1 g cm^{-3}.

Exercise C

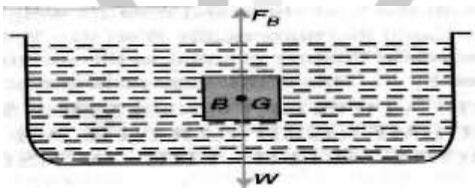
1. State the principle of floatation.

According to the principle of floatation, 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,

(1) Name the two forces acting on the body and draw a diagram to show these forces,

Two forces act on it (i) The weight W of the body acting vertically downwards, through the centre of gravity G of the body. (ii) The upthrust F_B of the liquid acting vertically upwards, through the centre of gravity of the displaced liquid, called the centre of buoyancy B.



(2) State how do the magnitudes of the two forces mentioned in part (i) determine whether the body will float or sink in the liquid when it is released,

The two forces W and FB acting on the body held immersed in a liquid. In magnitude

W = volume of body x density of body x g

F_B = volume of submerged part of body x density of liquid x g

(3) What is the net force on the body if it (a) sinks, (b) floats?

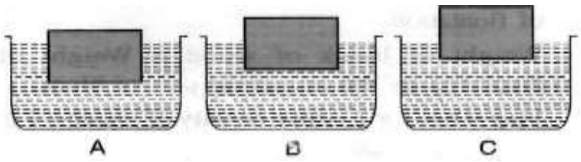
(a) When W > FB i.e., the weight of the body is greater than the weight of the displaced liquid than body sink.

(b) When W $\leq$ F_B i.e., the weight of the body is less than or equal to the weight of the displaced liquid than body float.

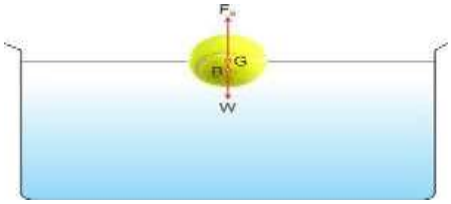
3. When a piece of wood is suspended from the hook of a spring balance, it reads 70 gf. The wood is now lowered into water. What reading do you expect on the scale of the spring balance?

Reading will be zero as the piece of wood will float on water and while floating, 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,
   Float, Reason: Density of ball (i.e., iron) is less than density of mercury,
   (b) What will be the apparent weight of ball ?
   Zero
5. **How does the density of a substance determine whether a solid piece of the given substance will float or sink in a given liquid?**
   Aus. 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.**
   Because the density of iron is less than that of mercury, but more than that of water so, it on mercury, but it sinks in water.
7. **A body floats in a liquid with a part of it submerged inside the liquid. Is the weight of floating body greater than, equal to or less than the upthrust?**
   Weight of the floating body is equal to the upthrust.
8. **A homogeneous 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 block.**
   (a) When it is partially immersed, its centre of buoyancy will be below the centre of gravity of block.
   (b) When it is completely immersed, its centre of buoyancy will coincide the centre of gravity.
9. **Fig. 8.8 shows the same block of wood floating in three different liquids A, B and C of densities ρ_1, ρ_2 and ρ_3 respectively. Which of liquid has the highest density? Give reason for your answer.**



   Answer – C
   Reason –The upthrust on the body by each liquid is the same and it is equal to the weight of the body. But upthrust = volume submerged x ρ_L x g. For liquid C, since volume submerged is least so density ρ_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?**



   The forces acting are as listed below:
   (i) Weight of the body acting downwards.
   (ii) Upthrust due to water acting upwards.

Weight of water displaced by the floating body = Weight of the body

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

The upthrust F_B of the liquid acting vertically upwards, through the centre of gravity of the displaced liquid, called the centre of buoyancy B. The centre of buoyancy coincides the centre of gravity G of the body if the body is completely immersed. But if the body is floating with its part submerged in liquid, the centre of buoyancy lies vertically below the centre of gravity G of the body.

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

Observation : The balloon will sink. J

Explanation: As the air is pumped out from the jar, j the density of air in the jar decreases, so the upthrust on the balloon decreases and it becomes zero when the jar gets fully evacuated.

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, give reason.

Ans (a) Floats with some part outside water.

Reason : On adding some salt to water, the density of water increases, so the upthrust on the block of wood increases and hence the block rises up till the weight of the water displaced by the submerged part of the block becomes equal to the weight of the block.

(b) water is heated? Give reason.

Ans. (b) Sinks.

Reason: On heating, the density of water decreases, so the upthrust on block decreases and the block sinks in water

14. A body of volume V and density ρ_s, floats with volume v inside the liquid of density ρ_L Show that

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

Let V be the volume of a body of density ρ_s. Let the body be floating with its volume v immersed inside a liquid of density ρ_L. Then

Weight of the body W = Volume of body x density of body x g

$= V \rho_s g$

Weight of liquid displaced by the body or upthrust F_B = Volume of displaced liquid x density of liquid x g

$= V \rho_L g$

For floatation, $W = F_B$

$V \rho_s g = V \rho_s g$

So, $$\frac{v}{V} = \frac{\rho_s}{\rho_L}.$$

15. Two identical pieces, one of ice (density = 900kg per meter cube) and other wood (density = 300kg per meter cube) float on water. (a) Which of the two will have more volume submerged inside water. (b) Which of two will experience more upthrust due to water.

(a) Ice will be more submerged inside water. Ice has a greater density than wood, although the volume of both is the same. So to support a greater amount of weight, ice needs to displace more water, and to displace more water, it has to be submerged more as compared to wood.

(b) As ice displaces more water, it will experience more upthrust.

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

Because the density of brine is more than the density of water so, the floating ice less submerged in brine than in water.

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

(1) Compare the weight of sea water and the river water displaced by him.

1 : 1 (in each case the weight of water displaced will be equal to the weight of the man)

(2) Where does he find it easier to swim and why?

In sea water because the density of sea water is more than that of river water so his weight is balanced in sea water with his less part submerged inside it.

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

A body of density greater than that of water sinks in water, while a body of density lower than that of water floats on the surface of water. If we place an iron nail on the surface of water, it sinks. This is because the density of iron is greater than that of water, so the weight of the nail is more than the upthrust of water on it (or the weight of water displaced by the nail). On the other hand, ships are also made of iron, but they do not sink. This is because the ship is hollow and the empty space in it contains air which makes the average density of ship less than that of water. Therefore, even with a small portion of the ship submerged in water, the weight of water displaced by the submerged part of the ship becomes equal to the total weight of the ship and therefore the ship floats.

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

Ans. Average density of ship is less than the density of water.

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

When a floating piece of ice melts into water, it contracts by the volume equal to the volume of ice pieces above the water surface while floating on it. Hence, the level of water does not change when ice floating on it melts.

21. A body 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 body in equilibrium, and state the direction in which each force acts.

Forces acting on the body are listed below:

(i) Weight of the body vertically downwards.

(ii) Upthrust of water on body vertically upwards.

(iii) Tension in thread vertically downwards.

22. A loaded cargo ship sails from sea water to river water. List your observations.

A ship submerges more as it sails from sea water to river water.

Density of river water is less than the density of sea water. Hence, according to the law of floatation, to balance the weight of the ship, a greater volume of water is required to be displaced in river water of lower density.

23. Explain the following

(1) Icebergs floating in sea are dangerous for ships.

The iceberg being lighter than water, float in water with their major part inside water and only a small part outside water, depending upon the density of sea water. Therefore for the driver of ship it becomes difficult to estimate the size of iceberg. Thus they are very dangerous for ships and the ships may collide with them.

(2) An egg sinks in fresh water, but floats in a strong solution of salt

Density of a strong salt solution is more than the density of fresh water. Hence, the salt solution exerts a greater upthrust on the egg which balances the weight of the egg, so the egg floats in a strong salt solution but sinks in fresh water.

(3) Toy balloons filled with hydrogen rise to ceiling, but if filled with CO2 sink to the floor.

Because the density of hydrogen is less than the density of air and the density of carbon dioxide is more than air so, hydrogen balloon float and carbin dioxide balloon sink in the air.

(4) As a ship in harbour is being unloaded, it slowly rises higher in water.

As a ship in harbor is unloaded, its weight decreases. As a result, displaces less water, and the ship's hull rises in water till the weight of the water displaced balances the weight of the unloaded ship

(5) A balloon filled with hydrogen rises to a certain height and then stops rising further.

The reason is that the density of air decreases as we move up in the upper atmosphere. Therefore as the balloon gradually goes up, the weight of the displaced air also decreases. Ultimately, when the weight of the displaced air becomes equal to the weight of the balloon, it stops rising further.

(6) A ship submerges more as it sails from sea water to river water.

The water of river and of different seas have different densities. Therefore, when a ship sails from the sea of water of higher density to the lower density of river water, it sinks further. The reason is that according to the law of floatation, to balance the weight of ship, a greater volume of water is required to be displaced in river of water of lower density.

24. Multiple choice type:

(1) For a floating body, its weight W and upthrust F_B on it are related as : $\underline{W = F_B}$

(2) A body of weight W is floating in a liquid.. Its apparent weight will be : <u>zero</u>.

(3) A body floats in a liquid A of density ρ_1 with a part of it submerged inside the liquid while in liquid B of density ρ_2 totally submerged inside the liquid. The densities ρ_1 and ρ_2 are related as : $\underline{\rho_1 > \rho_2}$.