# Floatation

## Periodic Test

**Q.1. Define thrust.**

**Answer:** The force acting on an object perpendicular to the surface is called thrust.

**Q.2. State the factors on which buoyant force depends.**

**Answer:** The factors on which buoyant force depends are:

- Volume of the liquid displaced
- Volume of the body submerged in liquid
- Density of the liquid
- acceleration due to gravity

**Q.3. Define relative density. What is its SI unit?**

**Answer:** The relative density of a substance is defined as the ratio of the density of substance to that of water.

It is a ratio and thus has no units.

$$\text{Relative density} = \frac{\text{Density of substance}}{\text{Density of water}}$$

**Q.4. Define pressure.**

**Answer:** Pressure is defined as the thrust per unit area. It is the force applied perpendicular to the surface of an object per unit area.

Its SI unit is Pascal (Pa).1 Pa=1N $m^{-2}$

**Q.5. State the principle of floatation.**

**Answer:** The principle of floatation states that a floating object displaces a weight of fluid equal to its own weight.

**Q.6. Give Reasons for the following:**

**Why is it difficult to hold a school bag having a strap made of a thin and strong string?**

**Answer:** The thin strap of school bag has very less area of contact. It is made up thin and strong string. The lesser area exerts more pressure on the shoulders. Thus, it is difficult to hold the bag after some time.

**Q.7. Give Reasons for the following:**

**Why does an object float or sink on the surface of water?**

**Answer:** If the density of the object kept on the surface of water is less than that of water, it floats.

If the density of the object kept on the surface of water is more than the density of water, it sinks in the water.

**Q.8. Give Reasons for the following:**

**Why does a mug full of water feel lighter inside water?**

**Answer:** When a mug full of water is dipped into the container of water, the water exerts an upward force on the mug. This upward force (buoyant force) decreases the net force on the mug and the mug feels lighter.

**Q.9. Give Reasons for the following:**

**Will the magnitude of up thrust change when more and more volume of a rigid body is immersed in water? When does this up thrust become minimum?**

**Answer:** The up thrust is equal to the weight of water displaced when the object is immersed in it. More the volume of submerged part of rigid body, more is the water displaced and thus more is the up thrust.

When the density of body is equal to the density of the water, the up thrust is minimum because the object just floats.

**Q.10. Give Reasons for the following:**

**A piece of ice floating in a glass of water melts but the level of water in the glass does not change. How do your account for this?**

**Answer:** When ice is immersed in water, it displaces the same amount of water as the volume immersed. When the ice floating in water melts, the added volume is same as the volume displaced before. The added volume is equal to the volume of water displaced and thus the water level does not change.

**Q.11. Density and relative density.**

**Answer: Density:** It is the mass per unit volume of a body.

$$\text{Density} = \frac{\text{Mass of body}}{\text{Volume of body}}$$

Its SI unit is kg m-3

**Relative density:** The relative density of a substance is defined as the ratio of the density of substance to that of water.

It is a ratio and thus has no units.

$$\text{Relative density} = \frac{\text{Density of substance}}{\text{Density of water}}$$

It has no unit because it is a ratio.

**Q.12. Thrust and pressure.**

**Answer: Thrust:** The force acting on an object perpendicular to the surface is called thrust. Its SI unit is Newton(N).

**Pressure:** It is the thrust exerted per unit area of a body. Its SI unit is Pascal (Pa).

**Q.13. Up thrust and weight.**

**Answer: Up thrust:** The up thrust is equal to the weight of water displaced when an object is immersed into it.

**Weight:** It is the force with which earth pulls a body towards the centre of the earth.

**Q.14. Conditions for floatation and sinking of a body.**

**Answer:** Conditions of floatation:

● when the weight of liquid displaced is equal to the weight of body

● when the weight of liquid displaced by a body is more than the weight of body.

Conditions for sinking of a body:

● when the weight of liquid displaced by body is less than the weight of body

● when the density of body is more than that of liquid

**Q.15. Archimedes' principle and principle of floatation.**

**Answer:**

| Archimedes' Principle | Principle of floatation |
|---|---|
| It states that when a body is immersed fully or partially in a fluid, it experiences an upward force that is equal to the weight of the fluid displaced by it. | It states that a floating object displaces a weight of fluid equal to its own weight. |
| | It is an application of Archimedes' principle. |

**Q.16. Describe briefly how can you arrive at Archimedes' principle theoretically.**

**Answer:** Archimedes Principle states that when a body is immersed fully or partially in a fluid, it experiences an upward force that is equal to the weight of the fluid displaced by it.

**We can observe it by the following activity:**

● Tie a stone at the end of a spring balance.

● Suspend the stone in air by holding the spring balance and observe the reading of the spring balance due to the weight of stone.

● Now, slowly immerse the stone in water in a container.

● As the stone is lowered in the water, the reading of spring balance decreases.

As we know that the reading of spring balance is due to the weight of the stone. The decrease in reading of the spring balance shows the loss in weight of stone due to some force acting on the stone in upward direction. This upward force exerted by the water is equal to the weight of water displaced by the stone. This approves the Archimedes principle.

**Q.17. How can you determine the relative density of a body using Archimedes' principle?**

**Answer:** According to Archimedes principle, when a body is partially or totally immersed in fluid, it experiences an up thrust force which is equal to the weight of fluid displaced.

The relative density of any substance is the ratio of density of that substance and water at 4°C.

In other words,

$$\text{Relative density} = \frac{\text{Density of substance}}{\text{Density of Water}} \quad \ldots (1)F$$

The first requirement is to know the density of the object.

$$\text{Density} = \frac{\text{Mass}}{\text{volume}}$$

From eq. (1),

$$\text{Relative density} = \frac{(g \times \text{Mass}) \text{ of given volume of water}}{(g \times \text{Mass}) \text{ of an equal volume of water}}$$

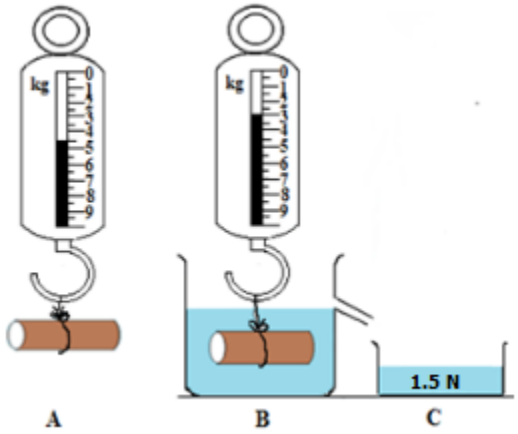
$$= \frac{\text{weight of given volume of water}}{\text{weight of an equal volume of water}}$$

Now,

The weight of a given volume of substance is the same as the weight of substance in air.

And, the weight of an equal volume of water is the same as the weight of water displaced (we are calculating relative density here, so liquid has to be water)

**Example:**




Here,

| |
|---|
| A is a real weight: (weight of an object in air) = 4.5 N |
| B is apparent weight: (weight of an object in fluid) = 3.0 N |
| C is apparent loss of weight: (weight of fluid displaced) = 1.5 N |

**Q.18. Relative density of mercury is 13.6. What is its density in SI unit?**

**Answer:**

$$\text{Relative density} = \frac{\text{Density of substance}}{\text{Density of water}}$$

$$\Rightarrow \text{Density of mercury} = \text{R. D.} \times \text{density of water}$$

$$\Rightarrow \text{Density of mercury} = 13.6 \times 1\ \text{gcm}^{-3}$$

$$\Rightarrow \text{Density of mercury} = 13.6\ \text{g cm}^{-3}$$

**Q.19. Calculate the mass of a body whose volume is 2 m and relative density is 0.5.**

**Answer:**

Given,

Volume = 2 $m^3$

R.D.= 0.5

$$\text{Relative density} = \frac{\text{Density of substance}}{\text{Density of water}}$$

$$\Rightarrow \text{Density of body} = \text{R. D.} \times \text{density of water}$$

$$\Rightarrow \text{Density of body} = 0.5 \times 1000\ \text{kgm}^{-3}$$

$$\Rightarrow \text{Density of body} = 500\ \text{kg m}^{-3}$$

$\text{mass} = \text{density} \times \text{volume}$ Putting the values,

$$\Rightarrow \text{mass} = 500 \times 2 = 1000\ \text{kg}$$

**Q.20. A solid weighs 50 gf in air and 45 gf when completely immersed in water. Calculate**

**(i) up thrust**

**(ii) volume of the solid**

**(iii) relative density of the solid.**

**Answer:**

Given,

weight in air=50 gf weight in water=45 gf

**(i)** Up thrust = loss in weight of solid when completely immersed in water=50-45=5 gf

**(ii)** Volume of the solid=volume of water displaced by the solid Now,

$$\text{Volume of water displaced} = \frac{\text{mass of water}}{\text{density of water}} = \frac{5 \times 10^{-3}}{1 \times 10^{3}}$$

volume of water displaced= $5 \times 10^{-6}$ $m^3$

**(iii)**

$$\text{Relative density} = \frac{\text{weight of solid in air}}{\text{weight of solid in air} - \text{weight in water}} \text{R. D.} = \frac{50}{50-45} = 10$$

**Q.21. A body has a face area of 100 cm and a mass of 100 N is placed on the table. What pressure is it exerting on the table?**

**Answer:**

Given,

Area of body= 100 $cm^2$

Mass = 100kg weight =mass × accn. due to gravity Weight=100 kg ×10 $ms^{-2}$

Weight=1000 N Here, the force is applied by the weight of the body.

$$\text{Pressure} = \frac{\text{Force}}{\text{Area}} = \frac{1000}{100 \times 10^{-4}} 10^5 \text{ Pa}$$

**Q.22. A wooden cube of side 10 cm floats in water with 3 cm above the surface of water. What is (i) mass of the cube (ii) density?**

**Answer:**

Given,

side of cube=10 cm Volume of cube=10×10×10=1000 $cm^3$

Now, length of side of cube above water=3 cm length of side of cube immersed in water=10-3=7 cm Volume of water displaced by the submerged part=10×10×7=700 $cm^3$

mass of the water displaced=density of water × volume of water displaced=1×700=700 $cm^3$

As the cube is floating, weight of cube=weight of water displaced=700 gf

**(i)** $$\text{mass of cube} = \frac{\text{weight of cube}}{\text{acceleration due to gravity}} = 700 \text{ g}$$

**(ii)** $$\text{density of cube} = \frac{\text{mass of cube}}{\text{volume of cube}} = \frac{700}{1000} = 0.7 \text{ g cm}^{-3}$$

**Q.23. Why does a ship float in water even though it is made of steel of density greater than the density of seawater?**

**Answer:** The volume of a ship is large. It is made hollow in the middle. The ship when placed in water, displaces a large portion of water due to its large volume. This displaced water applies an up thrust on the ship equal to the weight of the ship. The large volume makes its overall density less than that of water. That is why the iron ship floats in water.

**Q.24. It is easier to lift a stone underwater. Explain.**

**Answer:** According to Archimedes Principle, when a stone is immersed underwater, an upward force is applied on the stone with the magnitude equal to the weight of the stone. This upward force decreases the net force on the stone and it feels lighter.

**Q.25. How do snow-shoes prevent us from sinking into snow?**

**Answer:** The snow-shoes are made large and have larger surface area. Pressure is inversely proportional to the surface area of contact. The large area helps in exerting lesser pressure on the ice by the snow shoes and prevents us from sinking.

**Q.26. Why cutting instruments are sharpened?**

**Answer:** The cutting instruments apply high pressure on a body to cut it as per requirement. To apply high pressure on a body, the area of contact should be minimum.

Thus, the cutting instruments are sharpened to decrease the area of contact and increase the pressure applied by them. This results in smoother and better cutting with lesser force.

**Q.27. When is the pressure on the ground more when a man is (i) lying (ii) standing on the ground?**

**Answer:** The pressure applied on an object is inversely proportional to the area of contact. When the man is lying on the ground, the area of contact is much more than that when standing. Thus, the pressure is lesser when the man is lying on the ground.

## Comprehensive Exercises (MCQ)

**Q.1. A piece of wood is held underwater. The up thrust on it is:**

**A. equal to the weight of the wood**

**B. less than the weight of the wood**

**C. more than the weight of the wood**

**D. zero**

**Answer:** The up thrust on the wood is in the upward direction. It is the sum of the weight of wood and force applied to hold it underwater. Thus, it is more than the weight of wood.

**Q.2. The relative density of a solid is 0.6. It floats in water with:**

**A. whole of its volume inside water**

**B. 60% volume inside water**

**C. 60% volume outside water**

**D. 40% volume inside water**

**Answer:** The R.D. is 0.6. It means that it balances itself when it is 60% inside water.

**Q.3. A balloon filled with hydrogen rises upwards because:**

**A. hydrogen is an element**

**B. the pressure inside the balloon is greater than the pressure outside**

**C. hydrogen is a colourless gas**

**D. the weight of the balloon is less than the weight of the air displaced by it**

**Answer:** A body moves upward in a fluid if the up thrust experienced by it is more than the weight of the body. Since, the weight of balloon is less than that of displaced air, it experiences an up thrust more than its weight and moves upward.

**Q.4. An empty tin container with its mouth closed has an average density equal to that of liquid. The container is taken 2 m below the surface of the liquid and is left there. then the:**

**A. container will bounce back to the surface container remains where it is left**

**B. container remains where it is left**

**C. container sinks further**

**D. none of these**

**Answer:** The container is hollow from inside. It displaces a volume of water having weight more than the weight of container. Thus, it experiences an up thrust and bounces back to the surface.

**Q.5. The unit of relative density is:**

**A. kg m–3**

**B. g cm–3**

**C. g litre–1**

**D. it does not have a unit**

**Answer:** Relative density is a ratio of density of a substance to the density of water. Thus, it has no unit.

**Q.6. Two balls, one of iron and other of aluminium experience same up thrust when dipped in water.**

**A. both have equal volume**

**B. both have equal weight in air**

**C. both have equal density**

**D. nothing definite can be said**

**Answer:** The up thrust experienced by a body is independent of the weight of body. It depends on the volume of the liquid displaced by the body.

**Q.7. A wooden cube of side 10 cm has a mass of 700 g. It floats in water with:**

**A. half of its volume underwater**

**B. 3 cm above the water**

**C. 7 cm above the water surface**

**D. just inside the water surface**

**Answer:** The cube displaces water equal to its weight. When it immerses 7 cm, the volume of water displaced is 10x10x7 cm3 which is 700 cm3. The weight of displaced is 700 g. Thus, the cube starts floating.

**Q.8. Archimedes' principle states that when a body is totally or partially immersed in a fluid, the up thrust is equal to:**

**A. the weight of the fluid displaced by it**

**B. the weight of the body**

**C. volume of the fluid displaced**

**D. volume of the body**

**Answer:** Archimedes' principle states that when a body is totally or partially immersed in a fluid, the up thrust is equal to the weight of the fluid displaced by it.

## Comprehensive Exercises (T/F)

**Q.1. Write true or false for the following statements:**

**Relative density has no unit.**

**Answer:** True

Relative density is a ratio of density of a substance to the density of water. Thus, it has no unit.

**Q.2. Write true or false for the following statements:**

**Archimedes' principle does not apply to gases.**

**Answer:** False

It is applicable to all fluids.

**Q.3. Write true or false for the following statements:**

**Any solid will sink in water if its relative density**

**Answer:** False

**Q.4. Write true or false for the following statements:**

**Pressure exerted by a liquid at a point is the same everywhere in the liquid.**

**Answer:** False

Pressure exerted by a liquid at a point is the dependent on the depth of the point.

**Q.5. Write true or false for the following statements:**

**Buoyant force experienced by a body when fully immersed in air is less than that experienced by it in water.**

**Answer:** True

The fluid having higher density exerts more buoyant force on an immersed body than the fluid having lower density. As water is denser than air, buoyant force experienced by a body when fully immersed in air is less than that experienced by it in water.

**Q.6. Write true or false for the following statements:**

**The liquid having higher density exerts more buoyant force on an immersed body than the liquid having lower density.**

**Answer:** True

**Q.7. Write true or false for the following statements:**

**When an iceberg floats in sea water, only one tenth of its volume is inside the sea water.**

**Answer:** False

**Q.8. Write true or false for the following statements:**

**A body weighs 500 g in air and 300 g in water, it implies that upward thrust experienced in water is 500 gf.**

**Answer:** False

Up thrust = weight in air-weight in water

= 500 gf-300 gf

= 200 gf.