10. Gravitation (Floatation)

Assess Yourself

1. Question

An empty plastics bottle float, while a plastic bottle filled with sand sinks in water. Why?

Answer

The gravitational pull on the empty plastic bottle is less than the upthrust exerted on it by the water. In other words, its density is less than the density of water therefore it floats. On the other hand, a plastic bottle filled with sand sinks as the gravitational pull on it (weight) is more than the upthrust of water.

2. Question

How will the magnitude of buoyancy exerted by a liquid change if its volume is doubled?

Answer

As the magnitude of buoyant force depends on the density of the liquid therefore if volume increases it will decrease the density and hence there will be no effect on the magnitude of buoyant force as it depends both on density and volume proportionally.

$$\boldsymbol{B = \rho_f V g}$$

$B - buoyant\ force\ in\ N$
$\rho_f - fluid\ density\ in\ kg/m^3$
$V - displaced\ body\ volume\ of\ liquid\ in\ kg/m^3$
$g = 9.806\ m/s^2\ (standard\ gravity)$

3. Question

Why do buildings have wide foundations?

Answer

Since multi-story buildings have a huge structure which will exert tremendous pressure on the ground which will lead to the sinking of the

building into the ground or the building may collapse. In order to avoid such situations, foundations are made wide so that the pressure on the ground decreases as pressure is inversely proportional to area.

4. Question

A sheet of a paper falls slower than a coin under gravity through the air. Why?

Answer

Gravitational force depends on the mass of the object. The coin has more mass than the sheet of paper, therefore, force exerted on the coin will be more. On the other hand surface area of the sheet is more than coin; therefore air resistance will be more on the sheet of paper causing it to fall slow.

5. Question

State the SI unit of density. Relate it with its cgs unit.

Answer

SI unit of density is kilogram per cubic meter (kg/m^3). Its cgs unit is gram per cubic centimeter (g/cm^3). One g/cm^3 is equal to one thousand kg/m^3.

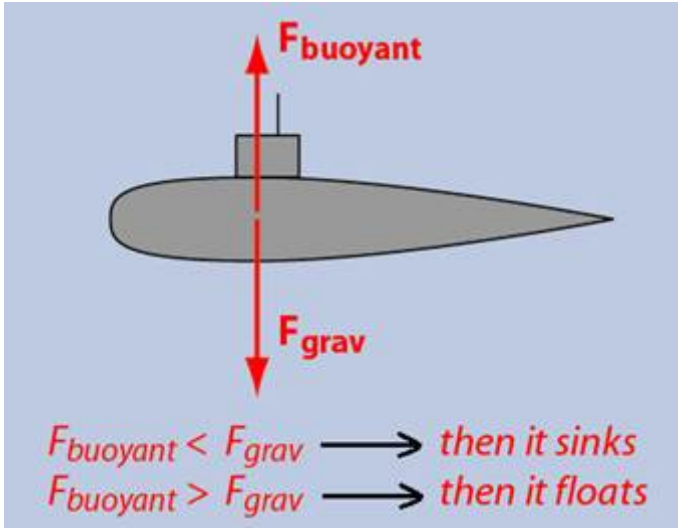
$1\ kg/m^3 = 1000\ g/cm^3$

6. Question

On what principle are submarines based?

Answer

Submarines are based on Archimedes' Principle. A submarine can dive into the water or rise to the surface as needed.



The compartments of a submarine that help in its floatation are the ballast tank and the compressed air tank. To sink, the ballast tanks are filled with water so that the average density of the submarine becomes greater than the

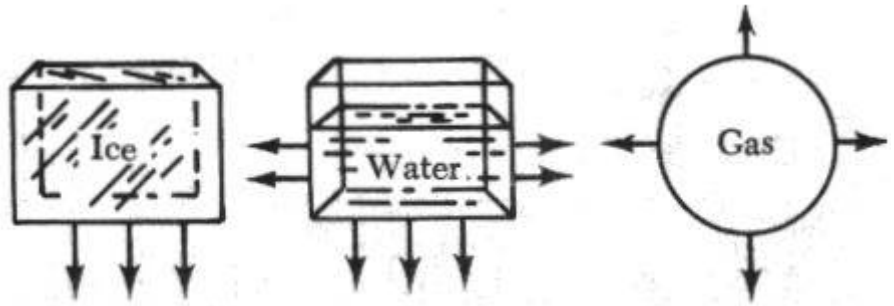
density of sea water, and the submarine sinks. To rise, the water from the ballast tanks is forced out into the sea by allowing air from the compressed air tank to enter the ballast tank. As a result, the average density of the submarine decreases, and the submarine rises.

7. Question

In which direction do fluids exert pressure?

Answer

Fluids exert pressure in all the directions. This is because the molecules of fluids are free to move in any direction and as soon as they encounter other object, fluids exert pressure on them.



8. Question

A solid ball and a hollow ball of the same size, are dropped from a height. The solid ball falls faster to the ground. Why?

Answer

The mass of the solid ball is more as compared to a hollow ball. Therefore gravitational force exerts more force on the solid ball. Also, air resistance acts on both the objects but it will act more on lighter objects and therefore decrease its velocity to fall down.

9. Question

A body lying on a mattress stands up on it. He observes that the mattress is now depressed deeper down. Why does this happen?

Answer

When the person was lying on the mattress, his weight was distributed throughout his body that is his surface area in contact with the mattress increases and as we know the pressure is inversely proportional to area, therefore, less pressure will be exerted on the mattress. As soon as he stands on his feet, the area decreases which is in contact with the mattress and therefore pressure increases causing the mattress to be depressed more.

10. Question

The relative density of silver is 10.8. The density of water is $10^3 kgm^{-3}$. What is the density of silver is SI units?

Answer

Relative density of silver = 10.8

The density of water = 10^3 kg-m^{-3}

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

10.8×10^3 kgm^{-3} = Density of silver

The density of silver = 10800 kg-m^{-3}

11. Question

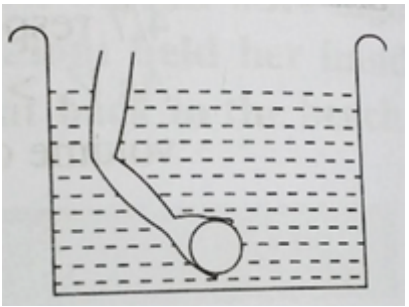
No one can sink in the Dead Sea. Do you agree? Give reason.

Answer

No one can sink in the Dead Sea is a misconception. The Dead Sea is highly saline that is salt content is very high. Due to the high salt content, the water of Dead Sea is denser than the freshwater. So objects which are denser than the salty water will sink while those which are not will float.

12. Question

A hollow plastic ball is taken to the bottom of a through of water and released there (see adjoining figure).



(a) What happens to the ball?

(b) Give a reason for this phenomenon.

Answer

(a) The ball will come on the surface of the water and will float there.

(b) The density of the ball is less than the density of water. The another reason could be the gravitational pull on the ball is less than the upthrust exerted by water.

13. Question

A wooden block is kept on a table top. The mass of the wooden block is 5 kg and its dimensions are 40 cm × 20 cm × 10 cm. Find the pressure exerted by the wooden block on the table top if it is made to lie on the table top with its sides of dimensions (a) 20 cm × 10 cm and (b) 40 cm × 20 cm.

Answer

Mass of wooden block = 5 kgDimension of the block = 40 cm × 20 cm × 10 cm= 0.4 m × 0.2 m × 0.1 m

Force = mass × acceleration due to gravity= 5 kg × 9.8 m/s^2

= 49 N

(a) 20 cm × 10 cm

Area = 20 cm × 10 cm = 0.2 m × 0.1 m = 0.02 m^2

Pressure = $\frac{\text{Force}}{\text{Area}} = \frac{49}{0.02}$ = 2450 N/m^2

(b) 40 cm × 20 cm

Area = 40 cm × 20 cm = 0.4 m × 0.2 m = 0.08 m^2

Pressure = $\frac{\text{Force}}{\text{Area}} = \frac{49}{0.08}$ = 612.5 N/m^2

14. Question

State Archimedes' principle. List its two applications.

Answer

Archimedes' principle states that when an object is fully or partially immersed in a fluid, it experiences an upward force that is equal to the weight of the fluid displaced by it.

The two applications of Archimedes principle are:

i) It is used to design ships and submarines.

ii) It is used to design hydrometer which is used to measure the density of different liquids.

15. Question

Define relative density of a solid. State its unit. How is it related to its density? Write mathematical expression for relative density. What conclusion do you draw if relative density of a substance is (a) greater than 1, (b) less than 1 and (c) equal to 1?

Answer

Relative density refers to the ratio of the density of a substance to the density of water.

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

(a) greater than 1: If the relative density is greater than 1, that means that the density of a substance is greater than the density of water.

(b) less than 1: If the relative density is less than 1, that means that the density of a substance is less than the density of water.

(c) equal to 1: If the relative density is equal to 1, that means that the density of a substance is equal to the density of water.

16. Question

It was raining heavily one day. Prateek made a paper boat and started playing with it in a water pool at road side. He then got his toys and dolls and made them boat riders the boat sank in water. Prateek did not lose courage. He made another boat and used lighter toys as passengers and this time boat did not sink in water.

(a) Why did not sink when loaded with dolls and toys?

(b) Which force is exerted by water on objects immersed in it?

(c) What qualities are shown by Prateek?

Answer

(a) The boat did not sink when Prateek used lighter dolls as the density of the dolls and the boat is much less than the density of water.

(b) Buoyant Force is exerted by water on the objects immersed in it. The gravitational pull exerted on them is much more than the buoyant force therefore they sank.

(c) Prateek is very patient as well as determined to achieve his goals. He does not lose hope and keeps on trying to fulfil what he wants.