

Chapter 3

FLUIDS

I) Choose the correct answer.

1) The size of an air bubble rising up in water

- (a) Decreases
- (b) Increases
- (c) remains same
- (d) May increase or decrease

Ans: (b) Increases

Explanation- We know that, the pressure experienced by the water depends on the depth of the water in that container. As the depth increases, pressure also increases. And the pressure is inversely proportional to the volume occupied. As the air bubble goes upwards, the pressure acting on it decreases and hence the volume of the air bubble increases. Hence, the size of the air bubble rising up in water increases.

2) Clouds float in atmosphere because of their low

- (a) Density
- (b) Pressure
- (c) velocity
- (d) Mass

Ans: (a) Density

Explanation- The density of the cloud of specific volume is less than the density of the same amount of volume in dry air. Thus, the clouds are less dense than dry air. Because of these reason, clouds floats in atmosphere because of their low density.

3) In a pressure cooker, the food is cooked faster because

- (a) Increased pressure lowers the boiling point.
- (b) Increased pressure raises the boiling point.

- (c) Decreased pressure raises the boiling point.
- (d) Increased pressure lowers the melting point.

Ans: (b) Increased pressure raises the boiling point.

Explanation- In the pressure cooker, due to heat supplied the steam is created which get trapped inside the cooker. Due to which the pressure increases inside it which raises the temperature of water and boiling point of water also increases. Hence, in pressure cooker the food is cooked faster.

4) An empty plastic bottle closed with an airtight stopper is pushed down into a bucket filled with water. As the bottle is pushed down, there is an increasing force on the bottom. This is because,

- (a) more volume of liquid is displaced.
- (b) More weight of liquid is displaced.
- (c) Pressure increases with depth.
- (d) All the above.

Ans: (c) Pressure increases with depth.

Explanation- Because, as the bottle is pushed down the depth of the water increases due to which pressure acting on it increases. Since, the depth of water is directly proportional to the pressure acting on it.

II. Fill in the blanks.

1) The weight of the body immersed in a liquid appears to be -----than its actual weight.

Ans: The weight of the body immersed in a liquid appears to be less than its actual weight. According to Archimedes' principle, when the body is partially or completely immersed in the water, the upward thrust equal to the liquid displaced acts on it. Due to this up thrust the body loses its weight.

2) The instrument used to measure atmospheric pressure is-----.

Ans: The instrument used to measure atmospheric pressure is barometer.

3) The magnitude of buoyant force acting on an object immersed in a liquid depends on----- of the liquid.

Ans: The magnitude of buoyant force acting on an object immersed in a liquid depends on density of the liquid.

4) A drinking straw works on the existence of-----.

Ans: A drinking straw works on the existence of **pressure**.

Explanation- Because, when the straw is suck up the air inside it is removed and vacuum is created inside it. But the pressure outside the straw is more which pull up the liquid inside the straw and reaches to mouth.

III) State whether true or false. If false, correct the statement.

1) The weight of fluid displaced determines the buoyant force on an object.

Ans: True

2) The shape of an object helps to determine whether the object will float or not.

Ans: False.

Explanation- Because, the density of the object determines whether the object will float or not.

3) The foundations of high-rise buildings are kept wide so that they may exert more pressure on the ground.

Ans: False

Explanation- Because, if the foundations of high-rise buildings are kept wide then the pressure exerted on the ground is less. Since, more the area less is the pressure. And hence, this avoids the sinking of building into the ground.

4) Archimedes' principle can also be applied to gases.

Ans: False

Explanation- Because, Archimedes' principle cannot be applied to gases, since the buoyant force exerted by gases is very small as compared to the fluids.

5) Hydraulic press is used in the extraction of oil from oil seeds.

Ans: True

Explanation- Because, hydraulic press machine uses the Pascal's law, according to which the pressure exerted on the fluids is used to extract oil from oil seeds.

IV) Match the following.

Ans: Density: Mass/ Volume

1 gwt: 980 dyne

Pascal's law: Pressure

Pressure exerted by a fluid: hpg

Lactometer: Milk

V) Answer in brief.

1) On what factors the pressure exerted by the liquid depends on?

Ans:

If we deep the bottle inside the water gently, the water exerts upward pull. As we go to the bottom the pressure exerted by liquid is more. Thus the pressure exerted by liquid depends on the depth mainly.

Also the pressure exerted depends on the density of the liquid. If the density is more pressure exerted will be more.

And the pressure exerted by liquid is given by $P = h\rho g$

Thus, the pressure exerted by the liquid depends on the following factors:

- a) Depth (h)
- b) Density of the liquid (ρ)
- c) Acceleration due to gravity (g)

2) Why does a helium balloon float in air?

Ans:

The density of helium balloon is less than air. That means the helium molecules are lighter than the oxygen and nitrogen molecules in air.

When the balloon is in air, the air exerts the pressure on the balloon.

The pressure at bottom is more than the pressure at the top. And this difference in pressure causes the force on the balloon which pulls it upwards. This force is called the buoyance force.

And helium is a most buoyant object because it has high volume and low density, and hence buoyance force will be more and floats in air easily.

3) Why it is easy to swim in sea water than in river water?

Ans:

There are many salts present in the sea water which increases the density of the sea water than the river water.

The more is the density then more is the buoyant force acting on the body which pulls up the body and helps in easy swimming.

The sea water experiences more buoyance force on the human body than the river water which has low density as compared to sea water. Due to which it is easy to swim in sea water than in river water.

4) What is meant by atmospheric pressure?

Ans:

The earth surrounded by layer of air up to a certain altitude. And this layer of air around the earth is called as atmosphere of the earth. The air has some weight and occupies space due to which it can exerts pressure which is called as atmospheric pressure.

If we go upward to an increasing altitude then layer of air becomes thinner and hence the atmospheric pressure will be less.

Also the layer of air gets heavier as we go down that is below the sea level like in mines. And hence at that place also atmospheric pressure decreases.

The human lungs are adapted to breathe at a pressure of sea level only. Above and below which we need the extra oxygen supply like oxygen cylinders.

5) State Pascal's law.

Ans:

According to Pascal's law the external pressure applied on an incompressible liquid is transmitted uniformly throughout the liquid.

In this effect or process there will be no loss of fluid.

It was given by a French mathematician and physicist Blaise Pascal.

The Pascal's law is applicable to incompressible fluids.

The hydraulic lift and hydraulic brakes are works on the principle of Pascal's law.

VI. Answer in detail.

1) With an appropriate illustration prove that the force acting on a smaller area exerts a greater pressure.

Ans:

The pressure exerted will be more if the area is less and it is less when the area is greater.

The best example to illustrate this is pushing of a pin into the board.

If we pushed the pin into the board from larger head, it cannot be pushed easily inside the board.

Whereas if we push the pin from the pointed side it can easily pushed into the board.

This is because, the pressure acting on the larger side is less than the pointed side. And hence, more pressure acts on pointed side which easily push it into the board.

Thus the pressure exerted is inversely proportional to the area of contact.

The camel can easily walk in desert, because they have the feet with larger area.

Due to which the pressure acting on sand is less and their feet can't push inside the sand which helps them to walk easily in desert also.

2) Describe the construction and working of mercury barometer.

Ans:

The instrument used to measure the atmospheric pressure is called as barometer.

The mercury barometer was designed by Italian physicist Torricelli.

Construction:

The following figure shows the construction of mercury barometer

The mercury barometer consist of a long glass tube with two ends, one end is closed and other is open.

This tube is filled with mercury and the topside is deepen into the container containing mercury.

This process is done by closing the open end by thumb and other end is deepen into the container.

Working:

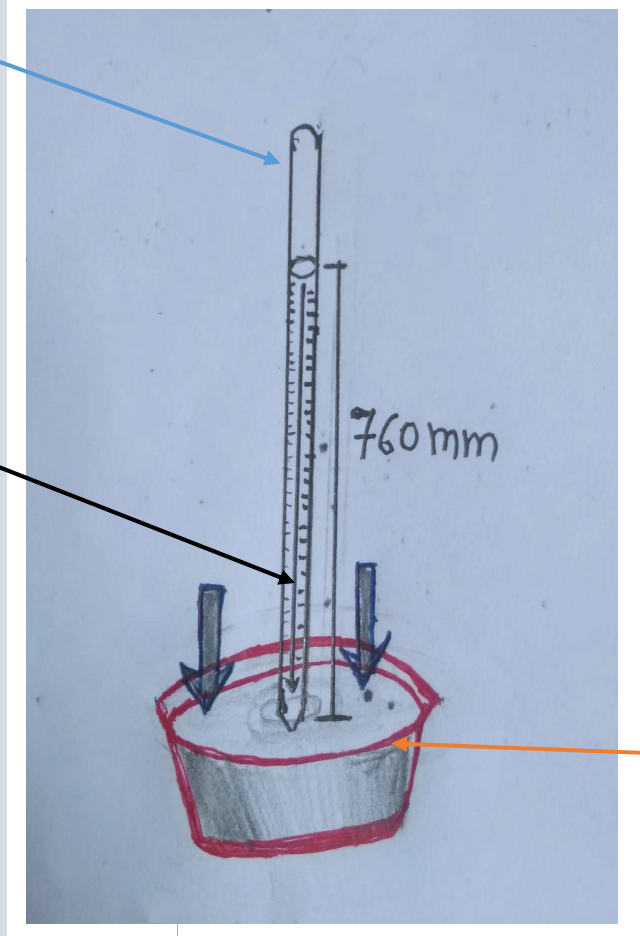
The barometer works in a way that the mercury inside the glass tube will be balanced against the outside air pressure.

If the outside air pressure increases which pushes the mercury up and up inside the glass tube.

And if outside air pressure is decreases then it pushes the mercury down inside the glass tube and more mercury is drain out in the container.

Vacuum

Pressure exerted
By the column of
mercury



Atmospheric pressure

Surface of mercury

Fig. Mercury barometer

Since, there is no air between the mercury and closed end and hence vacuum is created there.

So the mercury inside the glass tube gives the precise measure of pressure of air which is called as atmospheric pressure.

In this way the mercury barometer is used to measure atmospheric pressure in labs and at weather station also

3) How does an object's density determine whether the object will sink or float in water?

Ans:

The floating or sinking of object depends on the density of liquid and on the density of the object also.

If the density of the object is more than the water then it sink into the water.

If the density of the object is less than the water then it floats on the water.

Because, if the object is denser than the water then the upward push is less, due to sink the object get sink into the water.

If the object is less dense than water then upward push will be more which leads to float the object in water.

For example: if a small piece of wood is pulled in water then it floats in water because the density of wood is less than water.

Whereas in case of stone, the stone will deep in water because the density of stone is more than the water.

4) Explain the construction and working of a hydrometer with diagram.

Ans:

The hydrometer is a direct reading instrument used to measure the density or relative density of the liquid.

The hydrometer is based on the principle that, the weight of the liquid displaced by the hydrometer is equal to the weight of the hydrometer.

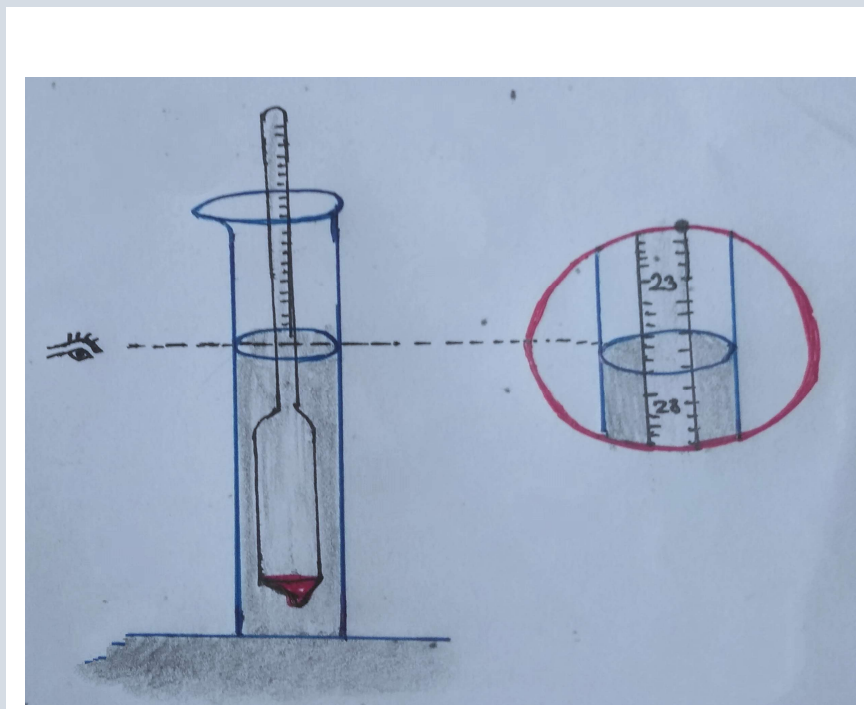
Construction:

The following figure shows the construction of hydrometer.

It consist of a cylindrical tube with spherical bulb at the lower end and a narrow tube at its upper end as shown in fig.

The lower bulb is filled with lead or mercury in order to float or stand in the liquid vertically.

The upper narrow tube has readings which are taken directly while measuring the density.



Hydrometer

Lead shots

Fig. Hydrometer

Working:

The liquid whose density is to be determined is placed into the glass jar and the hydrometer is gently deep inside the liquid until it floats freely on liquid.

The level of liquid touching the tube gives the relative density of the liquid.

In this way the hydrometer is used to measure the relative density or density of the liquid. On the basis of law of floatation.

5) State the laws of flotation.

Ans:

The laws of floatation are stated as follows:

1) The weight of floating body in the fluid is equal to the weight of the fluid displaced by the body.

That means, the body floating in fluid displaces the fluid equal to its weight only.

2) The center of gravity of the floating body and the center of buoyancy are on the same vertical line.

For example: if we put the wood piece into the water then it displaces the water equal to its weight only.

And it floats on the water because of its density is less than water.

VII) Assertion and reason type questions.

Mark the correct answer as:

- (a) If both assertion and reason are true and reason is the correct explanation of assertion.
- (b) If both assertion and reason are true but reason is not the correct explanation of assertion.
- (c) If assertion is true but reason is false.
- (d) If assertion is false but reason is true.

1) Assertion: To float, body must displace liquid whose weight is equal to the actual weight.
Reason: The body will experience no net downward force in that case.

Ans:

(a) If both assertion and reason are true and reason is the correct explanation of assertion.
Since, this is according to the laws of floatation.

2) Assertion: Pascal's law is the working principle of a hydraulic lift.

Reason: Pressure is thrust per unit area.

Ans: (b) if both assertion and reason are true but reason is not the correct explanation of assertion

Because, According to Pascal's law the external pressure applied on an incompressible liquid is transmitted uniformly throughout the liquid. And on this principle hydraulic lift works.

VIII) Numerical Problems.

1) A block of wood of weight 200 g floats on the surface of water. If the volume of block is 300 cm³, calculate the up thrust due to water.

Ans:

We know that, by the laws of floatation,

The weight of the body is equal to the upward thrust exerted.

Hence, weight of the body = upward thrust

$$m g = \text{upward thrust}$$

$$\text{Upward thrust} = m g = 200 \text{ g} * 9.8 \text{ m/s}^2$$

$$= 0.2 \text{ kg} * 9.8 \text{ m/s}^2$$

$$= 1.96 \text{ N}$$

Thus, the upward thrust due to water is **1.96 N**.

2) Density of mercury is 13600 kg m⁻³. Calculate the relative density.

Ans:

Given that, density of mercury = 13600 kgm⁻³

The relative density is given by,

Relative density = density of mercury/ density of water

But the density of water is = 997 kgm⁻³

$$\text{Relative density} = 13600 / 997 = \mathbf{13.64}$$

3) The density of water is 1 g cm⁻³. What is its density in S.I. units?

Ans:

Given that, the density of water in CGS system is = 1 g cm⁻³

But in SI system, 1g = 10⁻³ kg

And 1 cm = 10⁻² m

$$\begin{aligned} \text{Hence, the density of water in SI system is} &= (1 * 10^{-3} \text{ kg}) / (10^{-2} \text{ m})^3 \\ &= 10^{-3} / 10^{-6} \\ &= 10^3 \text{ kg/m}^3 \end{aligned}$$

Thus, the density of water in SI system is 1000 kg/m^3 or 103 kg/m^3 .

4) Calculate the apparent weight of wood floating on water if it weighs 100g in air.

Ans:

The apparent weight is given by,

Apparent weight = weight of body – weight of liquid

But, here given that the wood is floating on water having weight 100 g in air.

Hence, by the law of floatation, the body floats on the water only if the weight of body is balanced by the weight of the liquid displaced by it.

Hence, here weight of body = weight of liquid = 100 g

Thus, apparent weight of wood = $100 - 100 = 0$

IX) Higher Order Thinking Skills.

1) How high does the mercury barometer stand on a day when atmospheric pressure is 98.6 kPa?

Ans:

Given that, atmospheric pressure is 98.6 kPa

We know that, density of mercury = $\rho = 13600 \text{ kg/m}^3$

Atmospheric pressure = force/ area = $m g/a$

$$P = (mg h)/ ah$$

$$P = (mgh)/V$$

$$98600\text{Pa} = \rho g h = 13600 \cdot 9.8 \cdot h$$

$$h = 98600 / (13600 \cdot 9.8)$$

$$h = 0.739 \text{ m}$$

Thus, at atmospheric pressure 98.6 kPa the mercury barometer shows the height of 0.739m.

2) How does a fish manage to rise up and move down in water?

Ans:

The body structure of fishes is adapted to swimming. They have an internal swim bladder which is filled with gas. The bladder is filled with the oxygen from the water through the gills when there is need of rise up and move down into the water.

When the oxygen from the surrounding water is taken inside the volume of bladder increases, thereby decrease in its density.

And hence, the density of water is more than fish, due to which it easily floats or rise up in water.

On the other hand, when the oxygen from the bladder is removed through the gills, the volume of bladder decreases, thereby increase in density of fish.

And hence, the density of water is less than the density of fish, due to which it moves down inside the water.

3) If you put one ice cube in a glass of water and another in a glass of alcohol, what would you observe? Explain your observations.

Ans:

When we put the ice cube in a glass of water and another in a glass of alcohol, then it will be observed that, the ice cube in the glass filled with water floats easily.

Whereas the ice cube in the glass filled with alcohol sinks down.

This is because, the density of ice is less than the density of water and hence it will easily floats on the surface of water.

But, the density of ice cube is more than the density of alcohol, due to which it easily sinks inside the glass filled with alcohol.

4) Why does a boat with a hole in the bottom would eventually sink?

Ans:

The boat with a hole in the bottom would eventually sink because of the following reasons:

When there is no hole in the bottom of the boat, at that time the density of boat or weight is less than the density of water, due to which it floats on the surface of water.

But when, there is a hole in the bottom, the water enters through the hole inside the boat, due to which weight of the boat increases thereby increasing the density,

And hence finally, the density of boat would be more than water and it sinks eventually.

This is because, when the water enters through the hole the boat try to occupy the water equal to its weight and hence it sinks inside the water.