Chapter 4. Fluids

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Solution 1:
The thrust on the unit surface is known as pressure. The SI unit of pressure is Nm^{-2}.

Solution 2:
Pressure is given by
$P = h X_p X_g$.
Where h is height of liquid column, p is density of liquid, g is acceleration due to gravity.
Density of mercury is = 1.36×10^4 kg/m^3.
h= height of mercury column which is given = 75 cm = 0.75 m.
So pressure = 0.75 x 1.36 x 104 x 9.8 = $9.996 \times 10^4 Nm^{-2}$.

Solution 3:
Pressure is a scalar physical quantity.

Solution 4:
One pascal is defined as the pressure exerted on a surface of area 1 m^2 by a force of 1 Newton acting normally on the surface.

Solution 5:
The force acting normally on a surface is known as thrust.
SI unit of thrust is N.

Solution 6:

we know pressure exerted by a liquid column of height h, density ρ is
$P = h \times \rho \times g$.

Pressure exerted by mercury column of height 76 cm.

Density of mercury = 13.6 g/cc = 1.36×10^4 kg/m^3.

$P_{mercury} = 0.76 \times 1.36 \times 10^4 \times 9.8 = 10.12 \times 10^4 \ Nm^{-2}$.

Let height of water column = h m.

Density of water = 1g/cc = 10^3 kg/m^3.

$P_{water} = h \times 10^3 \times 9.8 = 9.8h \times 10^3 \ Nm^{-2}$.

Now put $P_{mercury} = P_{water}$

$9.8 h \times 10^3 = 10.12 \times 10^4$

h= 10.12/9.8 = 10.34 m.

So, 10.34 m height of water column would exert same pressure on its base as 76 cm column of mercury.

Solution 7:

Water can't be used in place of mercury in a barometer because of its low density. It would require 10.34 m long tube to measure 1 atmospheric pressure which is not practically possible while mercury having high density (13.6 g/cc) would require only 0.76 m long pipe which is practically possible.

Solution 8:

Pressure is the physical quantity which is measured in bar.

Solution 9:

Thrust is a vector quantity.

Solution 10:

Thrust on a surface is the force acting normally on a surface while pressure on a surface is thrust acting on the unit area of a surface.

Solution 11:

(i) we know pressure exerted by a liquid column of height h, density ρ is

$P = h \times \rho \times g$.

Pressure exerted by mercury column of height 70 cm.

Density of mercury = 13.6 g/cc = $1.36 \times 10^4 kg/m^3$.

$P_{mercury} = 0.7 \times 1.36 \times 10^4 \times 9.8 = 9.32 \times 10^4 Nm^{-2}$.

Let height of water column = h m.

Density of water = 1g/cc = $10^3 kg/m^3$.

$P_{water} = h \times 10^3 \times 9.8 = 9.8h \times 10^3 Nm^{-2}$.

Now put $P_{mercury} = P_{water}$

$9.8 h \times 10^3 = 9.32 \times 10^4$

h= 93.2/9.8 = 9.52 m.

So, 9.52 m height of water column would exert same pressure on its base as 70 cm column of mercury.

(ii) Height of the water column would not change if the cross section of the water column is made wider.

Solution 12:
Lake has greater pressure at the bottom than the surface as pressure increases with depth. So when gas bubble is released at the bottom of the lake it experiences more pressure and is small in size but as it rises upwards the pressure experienced by it decreases. So it grows in size as it moves towards the surface from bottom.

Solution 13:
A dam has broader walls at the bottom than at the top because the pressure exerted by a liquid increases with its depth, and at any point at a particular depth liquid pressure is same in all directions. Now as more pressure is exerted by water on the wall of the dam as depth increases. Hence a thick wall is constructed at the bottom of dam to withstand greater pressure.

Solution 14:

Depth of water = 6 cm = 0.06 m.

Density of water = 1000 kgm^{-3}.

Acceleration due to gravity = 10 ms^{-2}.

We know pressure

$P = h \times \rho \times g$.

$P = 0.06 \times 1000 \times 10 = 600\ Nm^{-2} = 600\ Pa$.

Area of base of cylindrical vessel = 300 cm^2 = $300 \times 10^{-4} m^2 = 0.03\ m^2$.

We know

Thrust = pressure × area.

Thrust = $600 \times 0.03 = 18$ N.

So thrust acting on base of vessel is 18 N.

Solution 15:
The pressure at a point in a liquid depends upon on the following three factors:

- It depends on the point below the free surface (h).
- It depends on density of liquid (p).
- It depends upon acceleration due to gravity (g) of the place.

Solution 16:

For calculating the total pressure in a liquid at a depth, we have to add the atmospheric pressure that acts on the free surface of the liquid.

Total pressure inside a liquid at depth 'h' = atmospheric pressure + pressure due to liquid column.

So Total pressure inside a liquid at depth = $P_0 + h\rho g$.

Here P_0 is atmospheric pressure acting on the free surface of liquid.

Solution 17:

A substance having a tendency to flow is called fluid.
A fluid exerts pressure on the bottom due to its weight and on the walls of the container in which it is enclosed by virtue of its ability to flow. This is called fluid pressure.

Solution 18:

The laws of liquid pressure are

- Pressure inside the liquid increases with the depth from the free surface of the liquid.
- Pressure is same at all points on a horizontal plane, in case of a stationary liquid.
- Pressure is same in all directions about a point inside the liquid.
- Pressure at same depth is different in different liquids. It increases with the increase in the density of the liquid.
- A liquid will always seek its own level.

Solution 19:

(i) When the diver moves horizontally the depth from the surface remains same and as we know that pressure at depth h is given by
$P = h \times \rho \times g$ so as depth remains same pressure would remains same while moving horizontally. (Density of liquid, g also remains same).

(ii) When diver moves to depth, depth h increases and thus pressure increases as diver moves to depth.

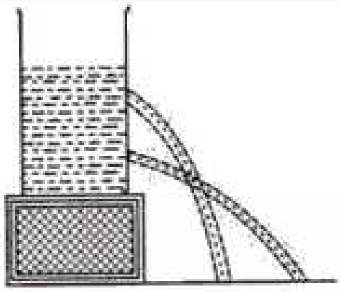
Solution 20:

A diving suit is a garment or device designed to protect a diver from the underwater environment.

Solution 21:

There are five main types of ambient pressure suits. These are wetsuits, drysuits, semidry suits, dive skins etc.

Solution 22:



This diagram illustrates that pressure of liquid increases with depth. Hole at greater depth has more pressure and hence flow of liquid from there is more. Other hole is at less depth so the pressure of liquid there is less and hence flow of liquid from there is less.

So the diagram shows that pressure increases with increase in depth.

Solution 23:

Manometer is a simple pressure gauge that measures differences in pressure at the two ends of the apparatus.
Manometer is a U shaped tube containing water whose one limb is dipped in vessel and vessel is tightly covered with plastic sheet. U shaped tube has two limbs one towards the vessel and other is opened to atmosphere.
Now if level of water toward atmospheric open limb is more than level of water in limb towards apparatus end then liquid is said to be at higher pressure than atmosphere. And if level of water toward atmospheric open limb is less than level of water in limb towards apparatus end then liquid is said to be at lower pressure than atmospheric pressure.

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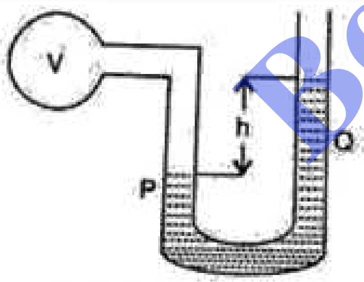
Solution 24:



(i) The pressure on the liquid surface in the limb Q is equal to atmospheric pressure i.e P_0.

(ii) According to manometer principle, difference in atmospheric pressure in two limbs is equal to difference in height of liquid in two limbs.
So pressure at P = pressure at Q + h×ρ×g.
$P_P = P_Q + h \times \rho \times g$.

Solution 25:
A hydraulic press works on the principle of pascal's law. A hydraulic press can be used for extracting juice of sugarcane, sugar beet etc.

Solution 28:
Pascal's law states that pressure applied to an enclosed liquid, is transmitted equally to every part of the liquid or in other words when pressure is applied at a point in a confined fluid, it is transmitted undiminished and equally in all directions throughout the liquid. Hydraulic machines such as hydraulic press, hydraulic brakes and hydraulic jack are application of pascal's law.

Solution 29:
Altimeter is a device which is used in an aircraft to measure its altitude.

Solution 30:
Atmospheric pressure decreases with increase in height. our atmosphere comprises of a large number of parallel layers. The pressure on a layer is equal to the thrust or weight of the gaseous column on the unit area of that layer. Hence, as we go up, the weight of the gaseous column decreases, which decrease the pressure of the gaseous column.

Solution 31:
Aneroid means containing no liquid and aneroid barometer is evacuated so it tends to collapse under the pressure of air. The stout spring balances the thrust on the metal box due to normal air pressure and prevents the box from collapsing. As this type of barometer doesn't contain any liquid so it got its name aneroid barometer.

Solution 32:
Barometer is a device which is used for measuring atmospheric pressure. Barometers are used in weather forecasting and in measuring altitudes.

Solution 33:
Mercury is used in barometer because

- It can be obtained in pure form.
- It does not vaporizeat ordinary temperatures.
- Its density is high and hence the length of the mercury column supported by atmospheric pressure is 76 cm which is practically possible.

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Solution 1:
All liquid exerts an upward force on the body placed in it. This Phenomenon is called buoyancy.

Solution 2:
The upward force which any liquid exerts upon a body placed in it is called the upthrust. The SI unit of upthrust is N.

Solution 3:
Buoyant force act on a body in upward direction.

Solution 4:
Upthrust is defined as the upward force on the object provided by the liquid because the object has displaced some of the fluid.

Solution 5:
When block of cork is immersed in water buoyant force acts on it in upward direction so to overcome this force we have to apply an equal force in downward direction to keep block of cork inside water.

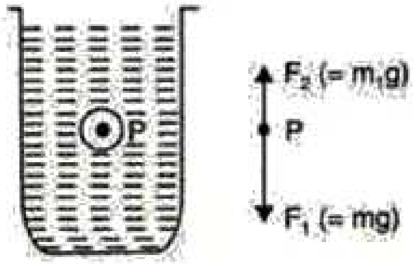
Solution 6:
Wood has density less than water so volume of water displaced by it is more than the volume of wooden block submerged so force of upthrust is greater than the weight of wood which pushes wooden block on the surface. Hence, a piece of wood when left under water again comes to the surface.

Solution 7:
A body will weigh more in air as weight of body acts in downward direction and there is no force in upward direction while body submerged in water weigh less because an upthrust act on the body in upward direction so the resultant weight of the body decreases.

Solution 8:
Upthrust or buoyant force depends on the following factors:

- Volume of body submerged in the liquid.
- Density of the liquid.
- Acceleration due to gravity.

Solution 9:



(i) F_2 represent the buoyant force acting on the stone in upward direction.
(ii) m_1 represent the apparent mass of the stone during motion through water.
(iii) Net force acting on the stone = $F_1 - F_2 = (m - m_1)g$.
(iv) Mass of stone = 200 gm =0.2 kg.
Volume of stone = 80 cm^3 = 80 × 10^{-6} m^3.
Density of water = 1 gcm^{-3} = 1000 kgm^3.
Acceleration due to gravity = 10 ms^{-2}.
Upthrust = V × ρ ×g.
Upthrust = 80 × 10^{-6} ×1000 ×10 = 0.8 N.
Weight of the stone = mass × gravity = 0.2 × 10 = 2 N.
Resultant weight of the stone = weight − upthrust = 2 N − 0.8 N = 1.2 N
Resultant acceleration of the gravity = m × a'
m×a' = 1.2 N
a'= 1.2/0.2 = 6ms^{-2}.
Resultant acceleration of the stone as it falls through the water is 6 ms^{-2}.

Solution 10:
Weight of the body in air = 300 gf.
Apparent Weight of the completely immersed body in water = 280 gf.

- Loss in weight of the body = Weight of body in air – apparent weight of immersed body.
  Loss in weight = 300 gf – -280 gf = 20 gf.
- As upthrust on the body = loss in weight
- So uptrust = 20 gf.

Solution 11:
Edge of metal cube = 5 cm.
Density of the metal cube = 9 gcm^{-3} = 9 x 10^3 kgm^{-3}.
Volume of the metal cube = 125 cm^3 = 125 x 10^{-6} m^3.
Mass of the metal cube =9 x 10^3 x 125 x 10^{-6} = 1125 x 10^{-3} =1.125 kg.
Weight of the liquid = mass x gravity = 1.125 x 10 = 11.25 N.
Density of liquid = 1.2 gcm^{-3}= 1.2 x 10^3 kgm^{-3}.
Upthrust of the liquid = V X_p X_g.
Upthrust = 125 x 10^{-6} x 1.2 x 10^3 x 10 = 1.5 N.
Apparent weight of the body = weight of liquid – upthrust
Apparent weight = 11.25 N – 1.5 N = 9.75 N
Tension in the string is equal to the apparent weight of the body
So, tension in string would be 9.75 N.

Solution 12:

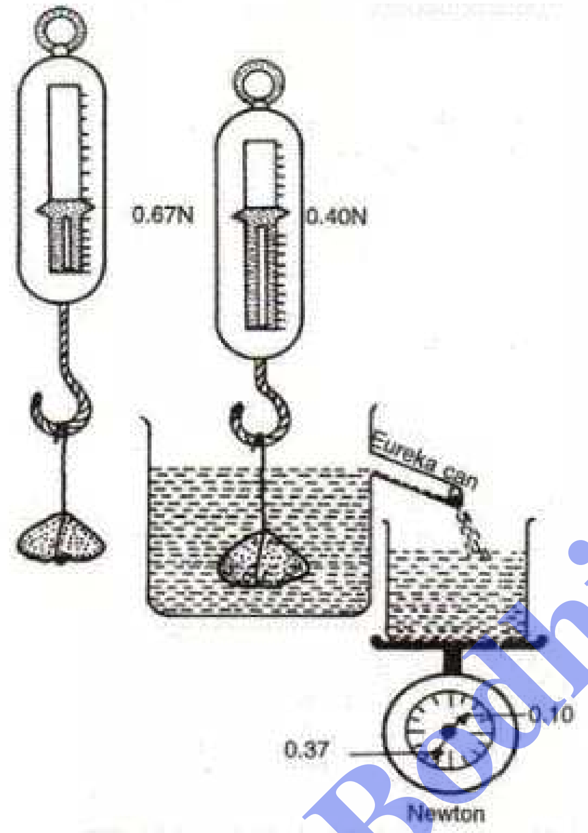
It is easier to lift a heavy stone under water because in water an upthrust acts on the upward direction which reduces the apparent weight of the stone and makes it easy to lift.

Solution 13:

Principle of Archimedes' states that when a body is totally or partially immersed in a fluid, it experiences an upthrust equal to the weight of the fluid displaced by it.

Solution 14:

We can verify archimedis' principle experimentally by doing this experiment.



The stone weighed 0.67 N in air and .40 N when immersed in water. The displaced water weighed is 0.27 N (= 0.67 – 0.40)

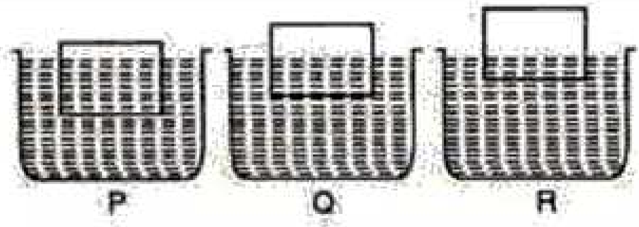
Pour water into eureka can till the water starts overflowing through the spout. When the water stops dripping replace the beaker by another one of known weight. Suspend a stone with the help of a string from the hook of a spring balance and record the weight of the stone.

Now, gradually lower the body into eureka can containing water and record its new weight in water when it is fully submerged in water. When no more water drips from the spout, weigh the beaker containing water.

After observation, we can conclude that apparent loss of weight of stone (calculated by differences in weight measured by spring balance) = weight of water displaced (weight of water in beaker).

This proves the archimedis' principle that when a body is totally or partially immersed in a fluid, it experiences an upthrust equal to the weight of the fluid displaced.

Solution 15:



The fractional part submerged equals the ratio of the density of the material of the block to the density of the liquid.

(Density of floating body / Density of liquid) = fraction submerged.

Density of liquid = (Density of floating body / fraction submerged)

Now in this case as density of floating body is same in all three cases. So, density of liquid is maximum when fraction submerged of wooden block is minimum.

As liquid R has least fraction submerged of wooden block in it So, it has maximum density.

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Solution 16:

Wood has density less than water so volume of water displaced by it is more than the volume of wooden block submerged so force of upthrust is greater than the weight of wood which makes it float on the water surface. And the apparent weight of the piece of the wood would be zero.

Solution 17:

Density of iron is less than the density of mercury so it will float on the surface of the mercury. Apparent weight of the floating iron ball is zero.

Solution 18:

Iron nail has density less than that of mercury so it will float on the surface of mercury but in the case of water it will sink because the density of iron nail is more than that of water.

Solution 19:

No, the relative density of a substance is the ratio of the density of the substance to the density of water at 4^0C.

Solution 20:

- SI unit of buoyant force is N.
- SI unit of density is Kgm^{-3}.
- SI unit of weight of body is N.
- Relative density is a pure ratio it has no dimension.

Solution 21:

Density of iron is more than the density of water so it sinks down in the water but in case of ship, it is design in such a manner that it encloses large quantity of air in air tight bags and in rooms and corridors which makes the average density of ship less than that of water and ship floats on the surface of the water.

Solution 22:
The fractional part submerged equals the ratio of the density of the material of the block to the density of the liquid.
(Density of floating body / Density of liquid) = fraction submerged.
The Fraction of ice submerged in water remain same as density of ice and water remain same during melting. As ice melts some volume of ice decrease and convert into water and volume of water increase by same amount. So, level of water remains same during melting.

Solution 23:
The fractional part submerged equals the ratio of the density of the material of the block to the density of the liquid.
(Density of floating body / Density of liquid) = fraction submerged.
Height of wooden piece = 15 cm.
Height of wooden piece sinks in water = 10 cm.
Fraction of wooden piece submerged in water = 10/15 = 0.67.
As liquid is water so ratio of Density of wooden by density of water gives relative density of floating wooden piece. So, relative density of wooden block is 0.67.
Height of wooden piece = 15 cm.
Height of wooden piece sinks in spirit = 12 cm.
Fraction of wooden piece submerged in water = 12/15 = 0.8.
We know density of wooden piece = 0.67
(Density of floating body / Density of liquid) = fraction submerged.
Density of liquid/spirit = (Density of floating body /fraction submerged)
Density of liquid/spirit = 0.67/0.8 = 0.83.
Relative density of spirit is 0.83.

Solution 24:

- When a body is completely immersed in water then it displaces equal volume of water to its own weight. Volume of body of man is same in both river and sea so weight of water of sea displaced by him is equal to the weight of water of river displaced by him. And ratio of weights would be 1:1.
- Sea water contains mineral salts and density of sea water increase due to presence of these. As density of sea water is more than the normal water so it apply more buoyant force than usual one and a person find it easy to swim in sea water.

Solution 25:
The fractional part submerged equals the ratio of the density of the material of the block to the density of the liquid.
(Density of floating body / Density of liquid) = fraction submerged.
Fraction of wooden piece submerged in water = 2/3 = 0.67.
As liquid is water so ratio of Density of wooden by density of water gives relative density of floating wooden piece.
So, relative density of wooden block is 0.67.
Density of water in SI system = 1000 Kg m^{-3}.
Density of wood=relative density x density of water =0.67 x 1000 Kg m^{-3} =670 kgm.
Fraction of wooden piece submerged in oil = 3/4 = 0.75.
We know density of wooden piece = 0.67
(Density of floating body / Density of liquid) = fraction submerged.

Relative Density of oil = (Relative Density of wooden block/fraction submerged)
Density of oil = 0.67/0.75 = 0.893.
Density of water in SI system = 1000 Kg m^{-3}.
Density of oil =relative density x density of water =0.893 x 1000 Kg m^{-3} =893 kgm^{-3}.

Solution 26:
Relative density of Ice = 0.92
Relative density of sea water = 1.025
Let total volume of iceberg = X cm^3.
Volume of iceberg above water = 800 cm^3.
Volume of iceberg in submerged in the water = (X – 800) cm^3.
Fraction of iceberg submerged = (X- 800)/X
Now we know that fractional part submerged equals the ratio of the density of the material of the block to the density of the liquid.
(Density of ice / Density of sea water) = fraction submerged
0.92/1.025 = (X-800)/X
0.8975 X = X – 800
X – 0.8975 X = 800
0.1025 X = 800
X = 800/0.1025 = 7804.8 cm^3.
Total volume of iceberg = 7804.8 cm^3.

Solution 27:
Relative density of wax = 0.95
Relative density of brine = 1.1
(Density of wax/ Density of brine) = fraction submerged
0.95/1.1 = fraction of volume submerged
Fraction of volume submerged = 0.86

Solution 28:
Relative density of Ice = 0.9 cm
Relative density of sea water = 1.1 cm
(Density of ice / Density of sea water) = fraction submerged of iceberg
0.9/1.1 = fraction of iceberg submerged
Fraction of iceberg submerged = 9/11.

Solution 30:
Lactometer is commonly used for testing the purity of milk.

Solution 31:
Density of water at 4^0c in SI system is = 1000 Kgm^{-3}.

Solution 32:
Side of wooden cube = 10 cm.
Volume of wooden cube = 10 x 10 x 10 = 1000 cm^3.
Mass of wooden cube = 700 g.
Density of wooden cube = mass/volume = 700/1000 = 0.7 gcm^{-3}.
Density of water = 1 gcm^{-3}.
(Density of floating body / Density of liquid) = fraction submerged

0.7/1 =fraction submerged
Fraction of wooden cube submerged in water = 0.7
Height of wooden cube = 10 cm
Part of wooden cube which is submerged = 10 x 0.7 = 7 cm
So, wooden cube will float in water with 3 cm height above the water surface.

Solution 33:

Volume of wooden block = 0.032 m^3.
Mass of wooden block = 24 Kg.
Density of wooden block = mass/volume = 24/0.032 = 750 Kgm^{-3}.
Density of water = 1000 Kgm^{-3}.
(Density of floating body / Density of liquid) = fraction submerged
750/1000 =fraction submerged
Fraction of wooden block submerged in water = 0.75
Total volume of wooden block = 0.032 m^3.
Part of volume of wooden block which is submerged = 0.032 x 0.75 = 0.024 m^3.

Solution 34:

Relative density = density of substance /density of water at 4^0C.
As relative density of platinum is 21.50, this means platinum is 21.5 times denser than water at 4^0C.

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Solution 35:

Density of mercury = 13600 Kgm^{-3}.
Density of water at 4^0C = 1000 kg m^{-3}.
Relative density = density of substance /density of water at 4^0C.
Relative density of mercury = 13600 Kgm^{-3}/1000 kg m^{-3} = 13.6.

Solution 36:

volume of body = 100 cm^3.
Weight of body = 1 kgf = 1000 gf
Mass of body= 1000 gm.
Density of liquid = 1000 gm/100cm^3 = 10 gcm^3.
Density of water at 4o = 1gcm^{-3}.
Relative density = density of substance /density of water at 4^0 C
Relative density = 10 gcm^3 /1 gcm^3 = 10
Mass of body= 1000 gm.
Density of water = 1 gcm^{-3}
Acceleration due to gravity = 10 ms^{-2}.
Upthrust = V X_p X_g.
Upthrust = 100 x 1 gf = 100 gf.
Resultant weight of the body = weight – upthrust = 1000 gf – 100 gf = 900 gf.

Solution 37:

When a body is completely immersed in water then it displaces equal volume of water to its own weight.

So, volume of body = 20000 cm^3.
Mass of body = 70 kg = 70000 gm
Density of body = mass /volume = 70000/20000= 3.5 gm cm^{-3}.
Density of water in C.G.S system = 1g cm^{-3}.
Relative density of body = density of body /density of water =3.5 gm cm^{-3}/1g cm^{-3}.
Relative density = 3.5.

Solution 38:
Relative density = density of mercury /density of water.
Density of mercury = relative density x density of water.
Relative density = 13.6.
Density of water in C.G.S system = 1g cm^{-3}.
So, density of mercury in C.G.S system = 13.6 x 1 = 13.6 gcm^{-3}.
Density of water in SI system = 1000 Kg m^{-3}.
So, density of mercury in SI system = 13.6 x 1000 = 13.6 x 10^3 $Kgcm^{-3}$.

Solution 39:
Density of iron is = 7.8 x 10^3 Kg m^{-3}.
Density of water at 4^0C = 10^3 Kg m^{-3}.
Relative density of a substance is the ratio of the density of the substance to the density of water at 4^0C.
So, relative density of iron is = 7.8 x 10^3 Kg m^{-3}/103 Kg m^{-3} = 7.8

Solution 40:

- Mass of a metallic piece remains unchanged with increase in temperature.
- Volume of metallic piece increases with increase in temperature.
- Density of metallic piece decreases with increases in temperature.

Solution 41:
Density of water decreases with the increase in temperature and increases with decreases in temperature.

Solution 42:
(i) Mass = VOLUME × density.
(ii) SI unit of density is Kgm^{-3}.
(iii) Density of water is 1000 Kgm^{-3}.
(iv) Density in Kgm^{-3} = 1000 × density in gcm^{-3}.

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Solution 1:
All liquid exerts a upward force on the body placed in it. This Phenomenon is called buoyancy.

Solution 2:
The upward force which any liquid exerts upon a body placed in it is called the upthrust.

Solution 3:
Pressure is a scalar quantity.

Solution 4:
Thrust is a vector quantity.

Solution 5:
SI unit of density is Kgm^{-3}.

Solution 6:
The relative density of a substance is the ratio of the density of the substance to the density of water at 4^0C.

Solution 7:
The pressure at a point in a liquid depends upon on the following three factors:

(i) It depends on the point below the free surface (h).
(ii) It depends on density of liquid (ρ).
(iii) It depends upon acceleration due to gravity (g) of the place.

Solution 8:
Principle of Archimedes' states that when a body is totally or partially immersed in a fluid, it experiences an upthrust equal to the weight of the fluid displaced. Yes, it applies to gases also.

Solution 9:
Thrust on a surface is the force acting normally on a surface while pressure on a surface is thrust acting on the unit area of a surface.

Solution 10:
Pascal's law states that pressure applied to an enclosed liquid, is transmitted equally to every part of the liquid or in other words when pressure is applied at a point in a confined fluid, it is transmitted undiminished and equally in all directions throughout the liquid.

Solution 11:
Yes, all liquid exert pressure.

Solution 12:
Hydraulic machines such as hydraulic press, hydraulic brakes and hydraulic jack are application of pascal's law.

Solution 13:
Pascal's law is principle of hydraulic machines.

Solution 14:
Brahma press depends upon Pascal's law.

Solution 15:

- A hydraulic press can be used for extracting juice of sugarcane, sugar beet etc.
- A hydraulic press can be used for pressing cotton bales, quilts, books etc.

Solution 16:
Atmospheric point at any point in air at rest is equal to the weight of a vertical column of air on a unit area surrounding the point, the column extending to the top of atmosphere.

Solution 17:
Atmospheric pressure at sea level is about 10^5 N/m^2.

Solution 18:
Barometer is used for measuring the atmospheric pressure.

Solution 19:
Altimeter is a device which is used in an aircraft to measure its altitude.

Solution 20:
A falling barometer indicates the approach of rain or storm or both.

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Solution 21:
A atmospheric pressure diving suit is a garment or device designed to protect a diver from the underwater environment. Yes, diving suits create buoyancy.

Solution 23:
A fluid exerts pressure on the bottom due to its weight and on the walls of the container in which it is enclosed by virtue of its ability to flow. This is called fluid pressure.

Solution 24:
A dam has broader walls at the bottom than at the top because the pressure exerted by a liquid increases with its depth, and at any point at a particular depth liquid pressure is same in all directions. Now as more pressure is exerted by water on the wall of the dam as depth increases. Hence a thick wall is constructed at the bottom of dam to withstand greater pressure.

Solution 25:
Pascal's law states that pressure applied to an enclosed liquid, is transmitted equally to every part of the liquid.
Means when pressure is applied at a point in a confined fluid, it is transmitted undiminished and equally in all directions throughout the liquid.

Solution 27:
Factors which affect the atmospheric pressure as we go up are

- Weight of gaseous column.
- Density of gaseous column.

Solution 28:
Atmospheric pressure decreases with increase in height. Our atmosphere comprises of a large number of parallel layers. The pressure on a layer is equal to the thrust or weight of the gaseous column on the unit area of that layer. Hence, as we go up, the weight of the gaseous column decreases, which decrease the pressure of the gaseous column.

Solution 29:
Barometer is a device used for measuring atmospheric pressure.

Simple barometer has two main defects

- It is not suitable for making accurate measurement of atmospheric pressure as any change in the level of mercury in the tube changes the level of the free surface of mercury is trough and fixed scale cannot be used with it.
- Simple barometer is not portable. So, it cannot be used by airmen, navigators, mountaineers, who need a portable barometer.

Solution 31:
We don't feel uneasy even under enormous pressure of the atmosphere above us because our blood also exerts a pressure called blood pressure, which is greater than atmospheric pressure. So, there is balance between our blood pressure and atmospheric pressure.

Solution 32:
Reading of a barometer would rise if it is taken to the mine as pressure increases with depth.
Reading of a barometer would fall if it is taken to a hill as pressure decreases with increase in height.

Solution 33:
Weight of solid in air = 2.10 N
Relative density of solid = 8.4
Now, Relative density = weight of solid in air/ loss of weight of solid in water.
Loss of weight of solid in water = weight of solid in air/ Relative density.
Loss of weight of solid in water = 2.10/8.4 = 0.25 N.
Weight of solid in water = weight in air – loss of weight in water
Weight of solid in water = 2.10 – 0.25 =1.85 N.
Relative density of liquid =1.2
We know
Relative density of liquid = Loss of weight of solid in liquid/loss of weight of solid in water.
Loss of weight of solid in liquid = Relative density x loss of weight of solid in water.
Loss of weight of solid in liquid = 1.2 x 0.25 = 0.3 N.
Weight of solid in liquid = weight of solid in air – loss of weight of solid in liquid.
Weight of solid in liquid = 2.10 – 0.3 = 1.8 N.

Solution 34:
Density of iron is 7800Kgm^{-3}.
This means a cube of iron having side 1m would weigh 7800 Kg.
Density of water at $4^{0}C$ is 1000 Kgm^{-3}.

Solution 35:
Relative density of body = 0.52
Density of water at $4^{0}C$ = 1000 Kgm^{-3}.
Density of body = 0.52 x 1000 Kgm^{-3}= 520 Kgm^{-3}
We know density = mass x volume.
Mass = density x volume
Mass = 520 x 2 =1040 Kg.
Mass of given body is 1040 Kg.

Solution 36:
Piece of metal weighs in air = 44.5 f

Piece of metal weighs in liquid = 39.5 f.
Loss of weight of metal in liquid = 44.5 – 39.5 = 5f.
Relative density = weight of solid in air/ loss of weight of solid in water.
Relative density of liquid =44.5f/5f =8.9
Relative density of liquid = 8.9

Solution 37:

Volume of body = 100 cm^3.

Weight of body = 1 kgf = 1000 gf

Mass of body= 1000 gm.

Density of liquid = 1000 gm/100cm^3 = 10 gcm^3.

Density of water at 4° = 1gcm^{-3}.

Relative density = density of substance / density of water at 4^0 C

Relative density = 10 gcm^3 /1 gcm^3 = 10

Mass of body= 1000 gm.

Density of water = 1 gcm^{-3}

Acceleration due to gravity = 10 ms^{-2}.

Upthrust = $V \times \rho \times g$.

Upthrust = 100 × 1 ×f = 100 gf.

Resultant weight of the body = weight – upthrust = 1000 gf – 100 gf = 900 gf.

Solution 38:
Principle of floatation states that a floatating body displaces an amount of fluid equal to its own weight.
Ship is designed in such a manner that it encloses large quantity of air in air tight bags and in rooms and corridors which makes the average density of ship less than that of water.

Solution 40:
Acid battery hydrometer is used to check the concentration of sulphuric acid in an acid battery.

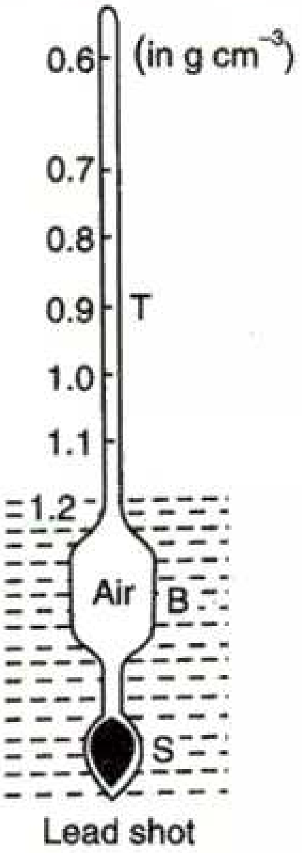
Solution 41:
Iron nail has density less than that of mercury so it will float on the surface of mercury but in the case of water it will sink because the density of iron nail is more than that of water.

Solution 43:

Principle of floatation states that a floatation body displaces an amount of fluid equal to its own weight.

Hydrometer is based on principle of floatation.

A hydrometer is a device used for measuring the relative density of a liquid directly.



Hydrometer

It usually consists of a glass float with a long thin stem which is graduated. The glass float is a large hollow bulb which increases with buoyancy. The narrow stem increases the sensitivity of hydrometer. The bottom of hydrometer is made heavier by loading it with lead shots so that it floats vertically.

Hydrometer works on the principle of floatation. Consider a thin walled and flat bottomed test tube. Add some lead shots in the test tube and place it in jar containing water. Adjust the number of lead shots such that it floats vertically with some of its portion outside the surface of water in jar.

If l is the length of the test tube inside water , a is area of cross section of the test tube, d is density of water in which it floats, then the weight of water displaced = $aldg$ and it is equal to the weight of loaded test tube.

Now allow the test tube to float in the other jar filled with a liquid of density d_1 and note the level l_1 at which it floats in that liquid.

Weight of the liquid displaced = al_1d_1g

Using law of floatation

$aldg = al_1d_1g$

$ld = l_1d_1$

$l/l_1 = d_1/d$

or l is inversely proportional to the density.

It sinks more in a lighter liquid so as to displace more volume of the lighter liquid whose weight is equal to the weight of Hydrometer. Hence, it will sink less in a denser liquid so that it has displace less volume of the denser liquid whose weight will be equal to the hydrometer. In this way this measures relative density of a liquid

Barometer can be used as lactometer which can be used to check the purity of milk.

Barometer can be used as acid battery hydrometer which can be used to check the concentration of sulphuric acid in an acid battery.

Solution 44:

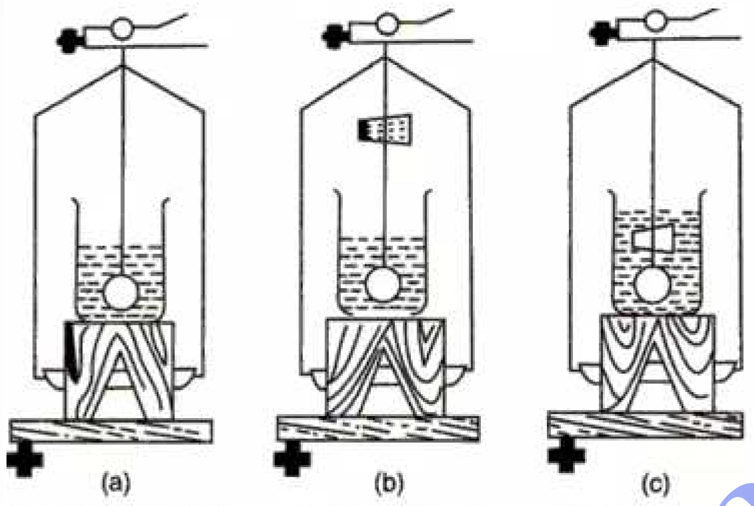
- A balloon filled with hydrogen has low density than air so it rises over the air but as height increases density of air decreases and at a certain height the density of hydrogen in balloon and density of air become equal. And as there is no density difference there is no pressure difference also and hence balloon stops rising further.
- Density of egg is greater than fresh water so it sinks in fresh water but due to addition of salt density of water increases which makes the density of salt water greater than egg and hence floats in a strong solution of salt.
- The bottom of the hydrometer is made heavier by loading it with lead shots so that it floats vertically with some of its portion outside the surface of water in the jar.
- Relative density of Ice is = 0.9 cm^{-3}
  Relative density of sea water is = 1 cm^{-3}
  (Density of ice / Density of sea water) = fraction submerged of iceberg

0.9/1 = fraction of iceberg submerged
Fraction of iceberg submerged = 9/10.

Thus in colder countries where there are icebergs in oceans, only about 1/10 is seen above water and the remaining water 9/10 remain submerged. Hence, there is danger of these icebergs to the ships sailing in these oceans.

Solution 45:

We can find the relative density of a solid which floats on water by following experiment.



Measuring the relative density of a cork

Choose a sinker and find its weight in water by suspending it in water.

Tie the solid to the string attached to the sinker and find its weight in air but sinker in water.

Remove the solid and tie it together with the sinker and suspend it in water and find the find the weight of the solid together with the sinker in water.

Record your observation as shown below:

Weight of sinker in water = x gf

Weight of sinker in water + solid in air = y gf

Weight of solid in air = (y – x) gf

Weight of solid + sinker in water = z gf

upthrust on solid in water = (y – z) gf.

The upthrust on in water also represents the weight of the water displaced by the solid.

Relative density of solid = (weight of cork in air)/(weight of equal volume of water)

Relative density = (y –x)/(y –z).

Solution 46:

We can find the relative density of a solid denser than water by following experiment.

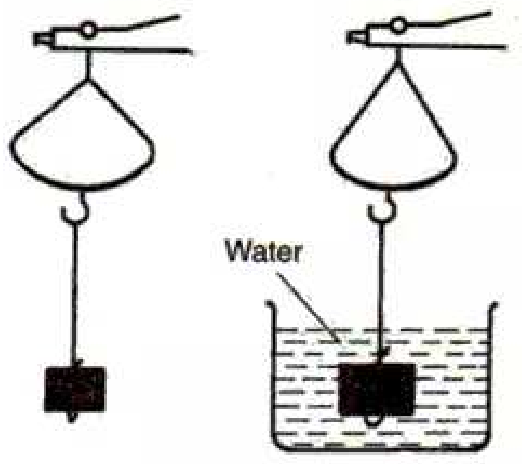


Fig. 8. *Weighing a solid in air and water*

Find the weight (W_1 gf) of a solid in air using a hydrostatic balance.

Tie the solid firmly with a thread and suspend it from the hook. Lower the solid in water and find its weight.

Record the result as shown below:

Weight of solid in air = W_1 gf.

Weight of solid in water = W_2 gf.

Apparent loss of weight of solid = ($W_1 - W_2$) gf.

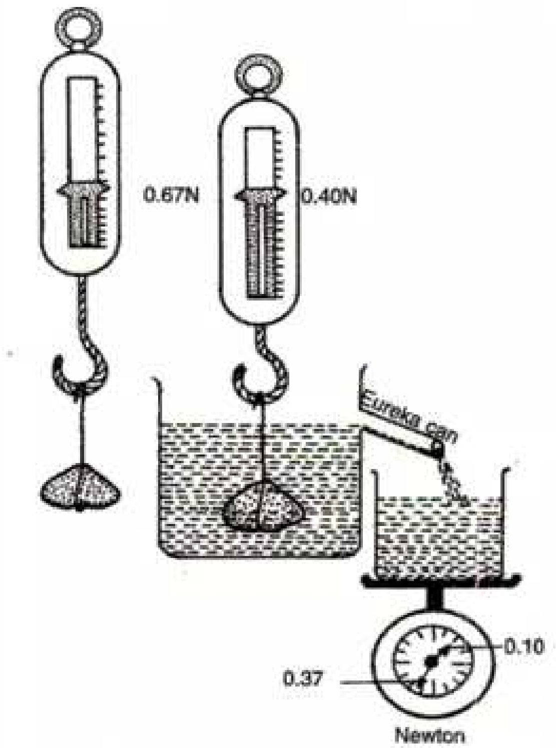
Relative density = $W_1/(W_1 - W_2)$

Relative density of the solid = (weight of solid in air)/(Apparent loss of weight of solid in water).

Solution 47:

Principle of Archimedis' states that when a body is totally or partially immersed in a fluid, it experiences an upthrust equal to the weight of the fluid displaced.

We can verify archimedis' principle experimentally by doing this experiment.



The stone weighed 0.67 N in air and 0.40 N when immersed in water. The displaced water weighed is 0.27 N (= 0.67 − 0.40)

Pour water into eureka can till the water starts overflowing through the spout. When the water stops dripping replace the beaker by another one of known weight. Suspend a stone with the help of a string from the hook of a spring balance and record the weight of the stone.

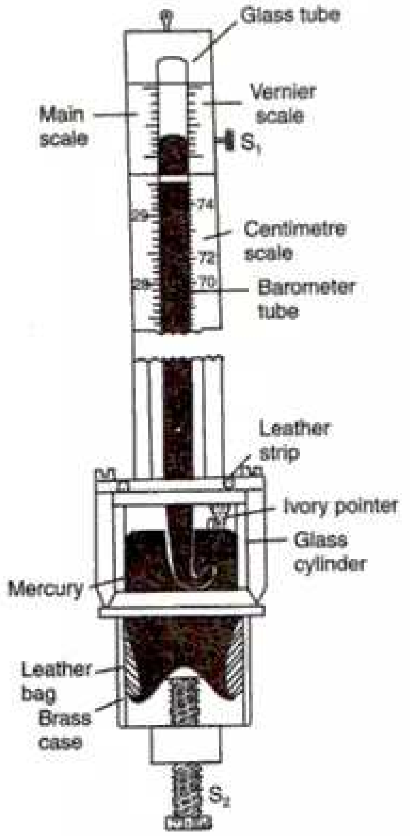
Now, gradually lower the body into eureka can containing water and record its new weight in water when it is fully submerged in water. When no more water drips from the spout, weigh the beaker containing water.

After observation, we can conclude that apparent loss of weight of stone (calculated by differences in weight measured by spring balance) = weight of water displaced (weight of water in beaker).

This proves the archimedis' principle that when a body is totally or partially immersed in a fluid, it experiences an upthrust equal to the weight of the fluid

Solution 48:

Barometer is a device for measuring atmospheric pressure.

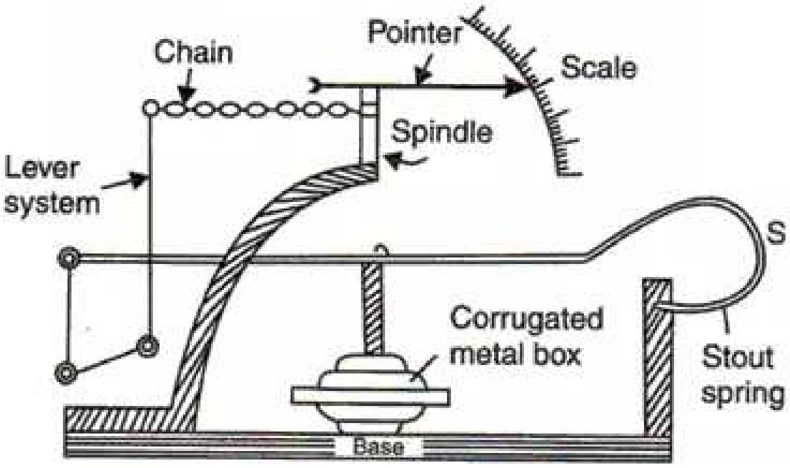


It consists of a long glass tube and of bore 1 cm^2 having thick walls and closed at one end. The tube is made wide to minimize the depression of mercury in the tube due to surface tension. The tube contains pure and dry mercury and stands inverted with its open end Immersed deep in mercury contained in trough called reservoir. The lower end of the tube is drawn out to avoid oscillations of mercury in the tube while making adjustment.

The barometer tube is enclosed for most of its length in a tube of brass. Near the upper end of the brass tube, there are two vertical rectangular slits cut diametrically opposite to each other. They enable us see the upper level of mercury through them. Two scales are engraved on the brass tube along the edges of front slit. The scale along one edge is graduated in centimeters and along the other in inches. The scales have graduations from 68 cm to 80 cm and 27 inch to 32 inch. It is so done as ordinarily the pressure varies only between these limits. The zero of both the scale is at the tip of an ivory pointer which projects downward from the ceiling of the reservoir. The pressure is read with a vernier scale.

Solution 49:

Aneroid barometer is a portable type of barometer.

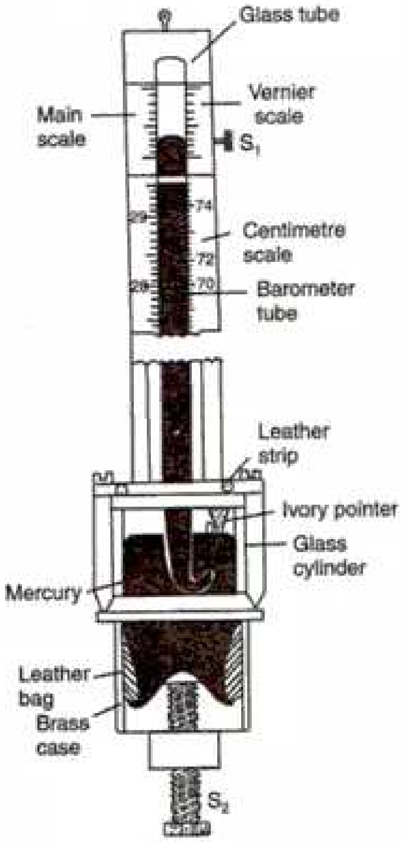


In this no liquid is used. It consists of a metal box corrugated to make it flexible. The lower side of the box is fixed to the base of the instrument and the upper side is supported by a stout spring S. The box is partially evacuated. So it tends to collapse under the pressure of air. The stout spring balances the thrust on the metal box due to normal air pressure and prevents the box from collapsing.

When atmospheric pressure changes, the surface supported by the spring S moves in if pressure increases or out if pressure decreases slightly. This small movement is increased considerably by a system of levers one end of which is connected to the spring S. The other end of the lever system is connected to a chain which is wrapped round a spindle carrying a pointer. The pointer moves over a scale which is graduated to read the pressure in centimeters or inches.

Solution 50:

Fortin barometer is used to measure the atmospheric pressure.

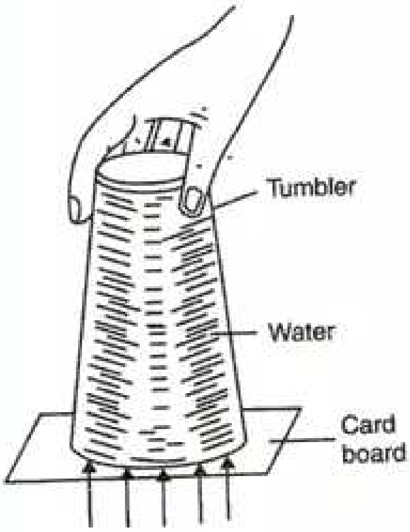


Before reading the fortin barometer, the free surface of mercury in the reservoir is made to touch the tip of ivory pointer by raising or lowering the level with the help of the screw S_2. The vernier scale is then adjusted with the screw S_1 till its lower edge touches the upper meniscus of mercury in the tube. While making this adjustment the eye is kept in level with the mercury meniscus. For this adjustment, the vernier is moved till the wall of glass plate just ceases to be visible through the slits. The vernier can read to 1/20 mm or 1/500 inch. The reading of the barometer then gives the true atmospheric pressure.

A thermometer is usually provided with the barometer which is also read and correction is made for the expansion of scale with rise in temperature and also for the change in density of mercury with temperature. The scale graduations are correct only for the temperature at which the graduations are made.

Solution 51:

Air exerts pressure and this can be demonstrated by this experiment.



Take a glass tumbler. Fill it to the brim with water, with water overflowing the rim of the tumbler. Cover it with a piece of cardboard. Press the cardboard so that it touches the rim of the tumbler at all points. This will ensure that no air is left inside.

With the hand on the cardboard, invert the tumbler gently and remove the hand. Both cardboard and water shall not fall. This shows that air exerts pressure on the lower surface of the cardboard in the upward as shown in figure. The upward thrust acting on the cardboard due to air pressure supports the combined weight of cardboard and water in the tumbler.

So, this shows that air exert pressure.