PHYSICS

BOOKS - CHHAYA PHYSICS (BENGALI ENGLISH)

HYDROSTATICS

Examples

1. By mixing 210 g of salt in 1 L of water, 1.05 L of solution is produced. Determine the density of that solution.

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2. How much of a liquid of density $1.3g \cdot cm^{-3}$ can be stored in a container of 5 kg of kerosene oil? Density of kerosene = $0.8g \cdot cm^{-3}$. Give your answer in kg.

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3. A liquid of mass m_1 and density ρ_1 is mixed with another liquid of mass m_2 and density ρ_2. If

the volume of the mixture does not change, then what will be the density of the mixture?

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4. The specific gravity of a mixture of two substances of equal volumes is 4. The specific gravity of the mixture becomes 3 when these two substances are mixed in equal masses. Calculate the specific gravity of the substances.

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5. The ratio of the densities of three liquids is 1 : 2 : 3. If they are mixed in (i) equal volume, (ii) equal mass, then what will be the densities of their mixtures?

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6. What amount of concentrated sulphuric acid (specific gravity 1.8) should be mixed with 1 L of water so that specific gravity of the mixture becomes 1.24?

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7. The mass of 1 L of milk is 1032 g. The milk contains 4% butter by volume. If the specific gravity of butter is 0.865, then find the density of butter-free milk.

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8. The mass of a coil of copper wire of diameter 1.2 mm is 150 g. If the density of copper is $8.9g \cdot cm^{-3}$, then find the length of the copper wire.

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9. The volume and mass of a piece of iron-aluminium alloy are $100cm^3$ and 588 g respectively. The specific gravities of iron and aluminium are 8 and 2.7 respectively. Calculate the ratio of the volumes of iron and aluminium on the alloy.

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10. Calculate the pressure at the bottom of a fresh water lake of depth 10 m. The atmospheric

pressure = 76 cm of mercury and the density of mercury = $13.6g \cdot cm^{-3}$.

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11. The length of a right circular cylinder filled with water is 4 m and its diameter is 1 m. At first, it is held upright on its base, and then is positioned laterally. Find the ratio of the thrusts exerted on its circular base in the above two cases.

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12. A hollow right circular cone of height h and of semivertical angle θ is placed with its base on a horizontal table. If the cone is filled with a liquid of density ρ and the weight of the empty cone is equal to the weight of the liquid that it contains, find the thrust of the liquid on the base of the cone and the pressure exerted on the table.

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13. The lockgate of a canal is 4.8 m broad. The depth of water on one side of the lockgate is 4.5

m and on the other side is 3m. Calculate the total thrust on the lockgate. The density of water = $1000kg \cdot m^{-3}$.

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14. An air bubble of diameter 1 mm is formed at the bottom of a lake and when it rises to the surface of the water, its diameter becomes 2 mm. If the atmospheric pressure is 760 cm of mercury, then find the depth of the lake. (Density of mercury = $13.6g \cdot cm^{-3}$)

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15. A large container with a cylindrical mouth is filled with water and closed with a piston. A vertical tube is now inserted through the piston. The radius of the tube is 5 cm, the radius of the piston is 10 cm and the mass of the pistoon is 20 kg. To what height will the water rise insdie the tube?

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16. At what depth below the surface of a lake will the total pressure be twice the atmospheric pressure? (Atmospheric pressure = 76 cm Hg and the density of mercury = $13.6g \cdot cm^{-3}$)

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17. A U-tube is partially filled with mercury. Kerosene oil is poured into one of its limbs and glycerine into the other. It is observed that, when the height of the kerosene oil becomes 20 cm and that of glycerine becomes 12.68 cm, the levels of

the mercury column in the two limbs are at the same horizontal level. If the density of kerosene oil is $0.8g \cdot cm^{-3}$, then find that of glycerine.

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18. A vertical U-tube of uniform cross-section contains mercury. Through one of its limbs, some water is poured such that the mercury level in that limb goes down by 2 cm. What will be the height of the water column?

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19. The cross-section of the two limbs of a U-tube are $3cm^2$ and $1cm^2$ respectively. Keeping the tube vertical, some mercury is poured into it. Now $60cm^3$ of water is poured into the wider limb. To what height will the mercury rise in the narrow limb? The density of mercury = $13.6g \cdot cm^{-3}$.

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20. One of the two limbs of a U-tube of uniform bore is closed by means of a cork. Some water and paraffin oil are in the tube. Water level in the

open tube is 2 cm higher than that in the closed tube and a 10 cm column of paraffin is above it. If the cork is removed, then by what height will the level of water in the closed limb rise or fall? (Density of paraffin = $0.8g \cdot cm^{-3}$)

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21. A vertical U-tube of uniform cross-section contains mercury in both its arms. A glycerine (density = $1.3g \cdot cm^{-3}$) column of height 10 cm is introduced into one of the arms. Oil of density $0.8g \cdot cm^{-3}$ is poured into the other arm until

the upper surfaces of oil and glycerine are at the same level. Find the height of the oil column. The density of mercury is $13.6g \cdot cm^{-3}$.

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22. The cross-sections of the two sides of a U-tube are $1cm^2$ and $0.1cm^2$ respectively. Some water is poured inside the tube when it rise to the same height in both the limbs. What volume of a liquid of density $0.85g \cdot cm^{-3}$ should be poured into the wider limb so that the water level rises by 15 cm in the narrow limb?

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23. The cross-sectional area of the left limb of a U-tube is one-third of that of its right limb. It contains some mercury. The empty space in the left limb measures to 40 cm. If water is poured to fill it up, then find the rise of the mercury column in the right limb. (Specific gravity of mercury = 13.6)

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24. A U-tube of uniform cross-section contains some mercury. If water is poured into one of the limbs up to a height of 13.4cm, then find the rise in the mercury level in the other limb. The density of mercury = $13.4g \cdot cm^{-3}$.

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25. Two cylindrical vessels of the same type contain a liquid of density ρ. The bases of both the vessels lie on the same horizontal plane. The depth of the liquid in the left vessel is h_1 and that

in the right vessel is h_2. The area of cross-section of the base of each vessel is A. If the vessels are connected by a tube, then how much is the work done by gravity to equalize the levels of the liquid in the vessels (suppose $h_1 > h_2$)?

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26. A tank, closed tightly with a lid, is completely filled with water and is rigidly fixed on a car. The car moves with a constant acceleration of $20cm \cdot s^{-2}$. Determine the pressure at a point 10

cm below the lid and at a distance of 10 cm from the front wall of the tank.

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27. In a hydraulic press, a 10^7 dyn force is applied on water by a piston of area $100cm^2$. If the other piston can raise a car of mass 2000 kg, then find its base area.

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28. The diameters of the two pistons of a hydraulic pressare 0.1 m and 1 m. The lengths of the two arms of a first class lever are 0.15 m and 0.9 m. A 50 N force is applied at the end of the lever. Determine the total thrust developed on the larger piston.

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29. A bottle completely filled with water is corked. The areas of the mouth and the bottom of the bottle are $10cm^2$ and $100cm^2$ respectively and the

height of the bottle is 40 cm. If the cork is pressed with a 10 N force, then calculate the total thrust on its bottom.

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30. A hydraulic automobile lift is used to life a car of mass 3000kg. The cross-sectional area of the piston on which the car is supported is $425cm^2$. What pressure would the smaller piston have to bear if the bigger piston with the car is 3m above the smaller piston? The density of the oil filling

the hydraulic machine is $800kg \cdot m^{-3}$. Let the pistons be of equal mass.

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31. The diameters of the larger and the smaller pistons of a hydraulic press are 45 cm and 5 cm respectively. Find the magnitude of the force that has to be applied on the smaller piston to produce a 4050 N thrust on the larger piston.

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32. A body weighs $100g \times g$ and $40g \times g$ in air and water respectively. Calculate the weight of the body when immersed in a liquid of specific gravity 0.8.

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33. The mass of a steamer is 10 tonnes. When it enters a fresh water lake from the sea, it displaces 50 L more water than before. Calculate the density of sea water. [Mass of 1L of fresh water = 1 kg]

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34. The internal and external diameters of a sphere are 8 cm and 10cm respectively. The sphere neither floats nor sinks in a liquid of specific gravity $1.5g \cdot cm^{-3}$. Calculate the density of the material of the sphere.

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35. A body of density ρ is placed slowly on the surface of a liquid of density δ. If the depth of the liquid is d, then prove that the time taken by the

body to reach the bottom of the liquid is $\left[\frac{2d\rho}{g(\rho-\delta)}\right]^{1/2}$ second.

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36. The weight of a body in air is $0.4g \times g$. Its weight along with an sinker in water = $3.37g \times g$. The weight of the sinker in air = $4g \times g$. Find the specific gravity of the body. [Specific gravity of the sinker = 8]

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37. A piece of wood of volume $20.5cm^3$ is tied to a piece of lead of volume $1cm^3$. State whether the combination will sink or float in water. [Specific gravity of wood and lead are respectively 0.5 and 11.4]

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38. A piece of an alloy of gold and silver weighs $25g \times g$ in air and $23g \times g$ in water. Find out the amount of gold and silver in the piece of alloy.

[Specific gravity of silver is 10.8 and that of gold is 19.3]

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39. There is a cavity inside a piece of metal of mass 237.3g. The apparent weight of the piece of metal immersed completely in water is $192.1g \times g$. If the density of the metal is $7.91g \cdot cm^{-3}$, then find the volume of the cavity.

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40. A piece of wood weights $40g \times g$ in air. A piece of brass of mass 12 g is tied to the wooden piece and the combination floats just totally immersed in water. If the specific gravity of brass is 8.5, calculate the specific gravity of wood. [Density of water = $1g \cdot cm^{-3}$]

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41. The apparent weights of two bodies suspended from the two ends of a balance beam and immersed in water are the same. The mass

and density of one body are 32g and $8g \cdot cm^{-3}$ respectively. If the density of the other body is $5g \cdot cm^{-3}$, then find its mass.

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42. A body of mass 25g is under water at a depth of 50 cm. If the specific gravity of the material of the body is 5 and g = $980cm \cdot s^{-2}$, find the amount of work required to lift it very slowly to the surface.

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43. A solid spherical ball having density d and volume v floats on the interface of two immiscible liquids. The density of the liquid in the upper portion is d_1 and that of the liquid in the lower portion is d_2. What parts of the ball will remain in the liquids in the upper and lower portions respectively, if $d_1 < d < d_2$?

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44. An object of density $12g \cdot cm^{-3}$ is weighed with some counterpoising weights made of brass

with the help of a common balance. Density of brass = $8g \cdot cm^{-3}$. If the buoyancy of air is neglected in this measurement of mass. Density of air = $1.2 \times 10^{-3} g \cdot cm^{-3}$.

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45. A rubber ball of mass 10 g and radius 2 cm is submerged in water up to a depth of 5 cm and released. Find the height up to which the ball pops up above the surface of water, neglecting the resistance of water and air. The density of water = $1g \cdot cm^{-3}$.

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46. The density of the material of a hollow sphere of radius R is ρ. Prove that the sphere can float on water if the thickness (t) of its wal satisfies the relation : $t \leq \frac{R}{3\rho}$.

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47. When a body is immersed separately into three liquids of specific gravities S_1, S_2 and S_3, its apparent weights become W_1, W_2 and W_3

respectivley. Show that $S_1(W_2 - W_3) + S_2(W_3 - W_1) + S_3(W_1 - W_2) = 0$.

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48. A body is floating on mercury keeping its $\frac{1}{4}$th part inside mercury. Now, water is poured into the container such that the body remains just immersed totally in water. Now what part of the body will remain immersed in mercury? [Density of mercury = $13.6g \cdot cm^{-3}$]

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49. A sugger crystal of mass 40 g is coated with wax of mass 5.76 g. The specific gravity of wax is 0.96. If the wax-coated sugar crystal weighs $14.76g \times g$ inside water, calculate the specific gravity of sugar.

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50. When a loaded cargo ship enters a river from the sea, it sinks by a length x. When the ship is totallly unloaded, it rises by a length y. When the

unloaded ship again enters the sea, it rises by z cm more. If the density of water of the river is ρ_w and the body of the ship is vertical, show that the density of sea water is $\frac{y\rho_w}{(z-x+y)}$.

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51. A cubical steel block floats on mercury erectly. If each side of the cube is 10 cm, (i) how much of the body is above the mercury surface? (ii) If water is poured over mercury and it just covers the upper surface of the cube, then what will be the depth of the water column? Densities of steel

and mercury are $7.8g \cdot cm^{-3}$ and $13.6g \cdot cm^{-3}$ respectively.

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52. A and B are two cylinders identical in size but made of different materials. A floats with half of itself immersed in a liquid. When B is placed on A, both the cylinders remain floating in the liquid, but completely immersed in it. Compare the density of the liquid and the densities of the materials of A and B.

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53. The apparent weight of a body in a liquid of density d_1 is m_1 and, in another liquid of density d_2, its apparent weight is m_2. What will be its apparent weight in a liquid of density d_3?

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54. A glass ball of density $2.6g \cdot cm^{-3}$ is coated with a thick layer of wax of density $0.8g \cdot cm^{-3}$. If the combination floats in water remaining

completely submerged, find the ratio of the volume of wax to that of the glass ball.

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55. A body can float on a liquid keeping $\frac{1}{4}$th of its volume outside the liquid. The body is completely immersed inside the liquid and then released. What will be its upward acceleration at that time?

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56. A drop of oil rises within water with an upward acceleration of αg. If α is a constant and g is the acceleration due to gravity, find the specific gravity of the oil. Neglect the friction of water.

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57. A stone of density $2.5g \cdot cm^{-3}$ is completely immersed in sea water and is allowed to sink from rest. Calculate the depth attained by the stone in 2s.

Neglect the effect of friction. The specific gravity

of sea water is 1.025, acceleration due to gravity = $980cm \cdot s^{-2}$.

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58. A uniform cube of side 10 cm weighs $880g \times g$. It is floating in saline water (specific gravity of saline water = 1.1). What will be the thrust on each face of the cube?

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59. A glass test tube with a plane base has a diameter of 4 cm and mass 30 g. Centre of gravity of the empty test tube is at a height of 10 cm from the base. Find the amount of water to be taken in the test tube so that when it floats vertially, its centre of gravity shifts to the midpoint of the immersed portionof the tube.

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60. A body of uniform cross-section remains floating in a liquid. The density of the liquid is 3

times that of the body. What part of that body remains outside the liquid?

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61. When a 300 g mass is placed over a wooden cube, the cube just floats in water. When the mass is removed, the cube comes out by 4 cm from the water. Determine the length of each side of the cube.

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62. From the two arms of a beam balance, a metal body weighing 20 g and a piece of glass are suspended. The apparent weights of these two bodies when measured in water are found to be the same. If immersed in alcohol instead of water, the mass of the metal needs to be increased by 0.84 g for balancing the beam. Calculate the mass of the glass piece. [Given, density of water = $1g \cdot cm^{-3}$, density of alcohol = $0.96g \cdot cm^{-3}$]

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63. A piece of silver weighing 105 gf and another piece of glass weighing 130 gf are placed on the right and left pan of a balance respectively. Which pan will move down when the balance is immersed in water? [Given, the density of silver, $\rho_1 = 10.5g \cdot cm^{-3}$ and density of glass, $\rho_2 = 2.6g \cdot cm^{-3}$]

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64. A body is fully immersed in water. Calculate the change in potential energy of the body, raised

to a height h inside the water.

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65. A soild uniform ball of volume V and density ρ floats on the interface of two immiscible liquids as shown in the figure. The density of the upper liquid is ρ_1 and that of the lower liquid is ρ_2 $(\rho_2 > \rho > \rho_1)$. What fraction of the volume of the ball will be in the upper liquid and what fraction will be in the lower one?

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66. To what height should a cylindrical vessel be filled with a homogeneous liquid such that the force exerted by the liquid on the wall of the vessel be equal to the force exerted by the liquid on the bottom of the vessel?

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Section Related Questions

1. Define density of a substance. What are the units of density in different systems of units?

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2. Define specific gravity. Why is it called relative density?

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3. Establish a relation between density and specific gravity.

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4. What are the relations between specific gravity and density in SI and in CGS system?

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5. Prove that in the CGS system the numerical values of density and specific gravity are equal.

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6. Determine an expression for the upward thrust acting on a solid body immersed in a liquid.

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7. On what factors does the buoyant force depend?

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8. What do you mean by the apparent weight of a body immersed in a liquid? State whether it is

more or less than the real weight.

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9. Write down the conditions of floatation and immersion of a body.

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10. A floating body is apparently weightless' - explain.

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11. If a body remains floating on a liquid, then what fraction of its volume remains immersed in the liquid?

Or, Prove that the immersed part of a body floating in a liquid is directly proportional to the density of the body.

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12. A lift is ascending with an acceleration a. A container of liquid of density ρ is kept at rest inside the lift. Determine the difference in

pressure at two points inside the liquid at different depths. Let the difference in depth of the two points be h.

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Higher Order Thinking Skill Hots Questions

1. How can a body be cut easily with the sharp edge of a knife, but not with its blunt edge?

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2. During the construction of a dam, why is the bottom of the dam wall made thicker than the top?

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3. Some liquid is kept in a container inside an artificial satellite revolving in a circular orbit around the earth. What will be the pressure at a point inside the liquid?

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4. A cylindrical vessel is filled with a liquid such that the thrust on the bottom of the vessel and that on its side wall become equal. Prove that the height of the liquid column in the cylinder is numerically equal to the radius of the vessel.

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5. A large shallow wooden container is filled with water. But the container does not crack. A hole is then made on the surface of the container and a long narrow tube is inserted vertically into the container through this hole. The tube is now filled

with water. It is seen that the container now cracks. Explain why.

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6. A vessel full of liquid is descensing with an acceleration a $[a < g]$. Find the relation between the liquid pressure with the depth of the liquid in the vessel.

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7. A cylindrical vessel contains a liquid up to a height h. A hole is made on the wall of the vessel. Water comes out through the hole and falls at a distance x from the base of the vessel. At what depth should the hole be created so that x becomes maximum?

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8. Prove that in static equilibrium the pressure exerted by a fluid decreases with its height.

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9. Two holes are made on the wall and at the bottom of a cylindrical vessel. Now the two holes are closed with two corks and the vessel is filled with water. If the vessel is now allowed to fall under gravity and the two holes are opened during its flight, then state what will happen.

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10. State whether pressure applied on any part of a confined liquid is transmitted instantaneously

to different parts of the liquid. Also state whether Pascal's law is applicable.

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11. Does a hydraulic press work, if the liquid used in it is replaced by a gas?

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12. Does the density have any significance in the weight - less state?

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13. A long cylinder is fitted with a top on its wall at its lower end. Keeping the top closed, the cylinder is filled with water. Now the cylinder is made to float by placing it over a cork and then the tap is opened. State what will happen.

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14. A cubical box is completely filled with water. Prove that the total thrust exerted by water on

one of the vertical walls is equal to half the weight of water kept in the box.

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15. (i) Prove that the density of the mixture of two substances with densities ρ_1 and ρ_2 of equal mass will be $\frac{2\rho_1\rho_2}{\rho_1+\rho_2}$.

(ii) Prove that if the two substance with densities ρ_1 and ρ_2 are mixed in equal volumes, then the density of the mixture thus formed will be $\frac{1}{2}(\rho_1+\rho_2)$

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16. State with reason whether Pascal's law is applicable to the water in a pond.

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17. A piece of iron (specific gravity = 7.8) sinks in water, but floats on mercury (specific gravity = 13.6) - explain why.

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18. Why is it easier to swim in sea water than in a river?

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19. Explain whether Archimedes' principle is applicable in the case of a freely-falling body under gravity.

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20. An empty balloon (or a soft plastic bag) weighs the same as what it does when filled with air at atmospheric pressure-explain why.

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21. A wooden block is floating on water in a closed vessel. What will happen (i) if the air above the water is compressed, (ii) if all the air above the water is removed from the closed vessel?

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22. Explain why it is sometimes safer for a ship while floating on water to load more goods than to get rid of them.

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23. A piece of ice is floating on a liquid of density $1.5g \cdot cm^{-3}$ kept in a beaker. Will there be any change in the level of the liquid in the beaker as the piece of ice melts completely?

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24. A wooden block is floating on water at $0^{\circ}C$ keeping a portion V of its volume outside water. If the temperature of the water is increased from $0^{\circ}C$ to $20^{\circ}C$, then what change of V will be observed?

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25. A piece of ice with a cork in it is floating on water in a beaker. Will the level of water in the beaker change after complete melting of the ice?

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26. A piece of ice with a stone in it is floating on water in a beaker. Will the level of water in the beaker change after complete melting of the ice?

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27. A man carries a bucket containing water in one hand and a live fish in the other. If he releases the fish into the bucket of water, will he carry less weight?

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28. A bird is sitting at the bottom of a cage and, in this condition, the cage is weighed with the help of a spring balance. Now, the bird starts flying inside the cage. Will the reading of the balance change?

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29. Two balloons of the same volume are filled with two gases at the same pressure, one with hydrogen and the other with helium. Which of the two experiences a greater upward force?

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30. An egg sinks in fresh water, but it floats when a suitable quantity of salt is mixed in that water. Why?

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31. A solid sphere and a hollow sphere having the same mass and external radius are immersed in the same liquid. Which one will feel heavier?

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32. A glass of water is placed on one of the pans of a balance. On the other pan, another similar glass of water is placed with a piece of wood floating on it. Water is at the same level in both the glasses. Which of the two glasses is heavier? Explain your answer.

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33. A flat disc, a solid cube and a solid sphere of equal mass made of the same material are completely immersed in water. Which one of them

will experience the minimum and which one will experience the maximum buoyant force?

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34. A hollow glass sphere is balanced by counterpoising weights made of brass in a common balance. The whole system is then covered with an air-tight bell jar and the jar is evacuated. What will be the result?

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35. A common balance has a beaker of water and a piece of stone in one of the pans and is balanced. Now, the stone is dipped into the beaker of water. Is any change in reading of the balance observed?

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36. What will happen if the upper part of a ship is made heavier than its lower part?

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37. Determine the change in potential energy of a body when it is raised through a height h, inside water. Volume of the body is V, its density is ρ and the density of water is ρ_0. Given your answer for the situations when (i) $\rho > \rho_0$ and (ii) $\rho < \rho_0$.

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Exercise

1. Sphere of iron and lead having same mass are completely immersed in water. Density of lead is

more than that of iron. Apparent loss of weight is w_1 for iron sphere and w_2 for lead sphere. Then w_1 / w_2 is

A. 1

B. between 0 and 1

C. 0

D. > 1

Answer: D

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2. The radius of a cylinderical container is r. When a liquid is poured into the container up to a height h, then the thrust on the bottom and that on the lateral surface of the container become equal. In this case

A. $h = \frac{r}{2}$

B. h = r

C. h = 2r

D. h = 4r

Answer: B

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3. The density ρ of water of bulk modulus B at a depth y in the ocean is related to the density at surface ρ_0 by the relation

A. $\rho = \rho_0\left(1 - \frac{\rho_0 gy}{B}\right)$

B. $\rho = \rho_0\left(1 + \frac{\rho_0 gy}{B}\right)$

C. $\rho = \rho_0\left(1 + \frac{B}{\rho_0 gy}\right)$

D. $\rho = \rho_0\left(1 - \frac{B}{\rho_0 gy}\right)$

Answer: B

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4. Two identical cylindrical containers contain a liquid of density d. The bases of the containers lie on the same horizontal plane. The depths of liquid in the base two containers are h_1 and h_2 respectively and the base areas of both containers is A. If the two containers are connected by a pipe, then the work done by gravity to equalize the levels of liquid in the two containers is

A. $(h_1 - h_2)gd$

B. $(h_1 - h_2)gAd$

C. $\frac{1}{2}(h_1 - h_2)^2 gAd$

D. $\frac{1}{4}(h_1 - h_2)^2 gAd$

Answer: D

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5. The dimensions of a black of iron of density $5g \cdot cm^{-3}$ are $5cm \times 5cm \times 5cm$. It is weighed by immersing it completely in water. Its apparent weight will be

A. $(5 \times 5 \times 5 \times 5) \times g$

B. $(4 \times 4 \times 4 \times 5) \times g$

C. $(3 \times 5 \times 5 \times 5) \times g$

D. $(4 \times 5 \times 5 \times 5) \times g$

Answer: B

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6. There is a layer of oil over mercury in a container. The density of mercury is $13.6g \cdot cm^{-3}$ and that of the oil is $0.8g \cdot cm^{-3}$. A homogeneous sphere remains immersed with half of its volume in mercury and the other half in oil.

The density of the material of the sphere in $g \cdot cm^{-3}$ is

A. 3.3

B. 6.4

C. 7.2

D. 12.8

Answer: C

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7. When a block is suspended in air from a spring balance, it reads 60 N. When the block is immersed completely in water, the spring balance reads 40 N. The specific gravity of the block is

A. $\frac{3}{2}$

B. 6

C. 2

D. 3

Answer: D

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8. A wooden cubic block with a 200 g mass floats in water just fully immersed. When the mass is removed, the block floats up by 2 cm. The length of each side of the cube is

A. 5 cm

B. 10 cm

C. 15 cm

D. 20 cm

Answer: B

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9. A piece of ice of density $900kg \cdot m^{-3}$ floats on water. The part of the piece of ice that remains outside the water surface is

A. 0.2

B. 0.35

C. 0.1

D. 0.25

Answer: C

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10. Two stretched membranes of area $2m^2$ and $3m^2$ are kept at the same depth in a liquid. The ratio of the pressures on them is

A. $1:1$

B. $2:3$

C. $\sqrt{2}:\sqrt{3}$

D. $2^2:3^2$

Answer: A

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11. If a pressure is applied on any part of an enclosed fluid, then that pressure

A. acts on all parts of the fluid with increased magnitude

B. acts on all wall of the container with decreased magnitude

C. increases according to the mass of the fluid and is then transmitted

D. is transmitted throughout the fluid with undiminished magnitude and acts normally

on the wall of the container in contact with the fluid

Answer: D

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12. The pressure exerted by a liquid at the bottom of the container containing the liquid does not depend on

A. accelerating due to gravity

B. height of the liquid column in the container

C. area of the bottom of the container

D. density of the liquid

Answer: C

Watch Video Solution

13. Bar is a unit of pressure. 1 bar = ?

A. 10^4 Pa

B. 10^5 Pa

C. 10^6 Pa

D. 10^7 Pa

Answer: B

Watch Video Solution

14. The working principle of a hydraulic press depends on

A. Boyle's law

B. Pascal's law

C. Dalton's law of partial pressure

D. Newton's law of gravitation

Answer: B

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15. A thin uniform cylindrical shell, closed at both ends is partially filled with water. It is floating vertically in water in half-submerged state. If ρ_c is the relative density of the material of the shell with respect to water, then the correct statement is that the shell is

A. more than half filled is ρ_c is less than 0.5

B. more than half filled if ρ_c is less than 1.0

C. half filled if ρ_c is less than 0.5

D. less than half filled if ρ_c is less than 0.5

Answer: D

View Text Solution

16. Which of the following works on Pascal's law?

A. barometer

B. hydraulic lift

C. venturimeter

D. sprayer

Answer: B

View Text Solution

17. If the liquid used in a hydraulic press is replaced by a gas, then the press

A. continues to work as before

B. does not work

C. works but cannot be used for heavy duty

D. none of the avoe

Answer: C

View Text Solution

18. The radii of two thin circular discs are 0.03 m and 0.04 m respectively. They are placed inside a liquid at the same depth. The ratio of the thrusts acting on them is

A. $9:16$

B. $3:4$

C. $4:3$

D. $\sqrt{3}:2$

Answer: A

Watch Video Solution

19. The diameters of the smaller and larger pistons of a hydraulic press are d_1 and d_2 respectively. If the force applied on the smaller piston is F_1, then the force developed on the larger piston will be

A. $F_2 = \frac{d_2^2}{d_1^2} \cdot F_1$

B. $F_2 = \frac{d_1^2}{d_2^2} \cdot F_1$

C. $F_2 = \frac{d_1^2}{d_2^2} \cdot \frac{1}{F_1}$

D. $F_2 = \frac{d_2^2}{d_1^2} \cdot \frac{1}{F_1}$

Answer: A

Watch Video Solution

20. A hole is made at a depth h on the wall of a container containing a liquid. The velocity of efflux of the liquid through the hole is

A. zero

B. $\sqrt{gh}$

C. $\sqrt{2gh}$

D. dependent on the density of the liquid

Answer: C

 Watch Video Solution

21. A cylindrical vessel contains water up to a height H. A hole is made on the wall of vessel. If the jet of water coming out from the hole traverses the maximum distance from the base of the vessel, then the hole is situated

A. at a depth H from the upper surface of water

B. at a depth $\frac{H}{2}$ from the upper surface of water

C. at a depth $\frac{H}{4}$ from the upper surface of water

D. at a depth $\frac{3H}{4}$ from the upper surface of water

Answer: B

View Text Solution

22. A tank contains water up to a height H. A hole is made at a depth h from the upper surface. The horizontal range of the jet of water coming out from the hole is

A. $2\sqrt{h(H-h)}$

B. $4\sqrt{h(H+h)}$

C. $4\sqrt{h(H-h)}$

D. $2\sqrt{h(H+h)}$

Answer: A

Watch Video Solution

23. Of the following substances, which one can be lifted upwards with more ease with the help of a hydrogen-filled balloon?

A. 1 kg steel

B. 1 kg feather

C. 1 kg lead

D. 1 kg water

Answer: B

View Text Solution

24. A man is carrying a bucket of water in one hand and a piece of plastic in the other. When the piece of plastic is dropped into the water of the bucket, then the man

A. carries more weight than before

B. carries less weight than before

C. carries the same weight as before

D. carries more or less weight than before depending on the density of the plastic

Answer: C

Watch Video Solution

25. A body remains floating in a liquid kept in a beaker. If the entire system falls under gravity, then the upthrust of the liquid acting on the body will be

A. zero

B. equal to the weight of the displaced liquid

C. equal to the weight of the part of the exposed to air

D. equal to the weight of the immersed part of the body in that liquid

Answer: A

Watch Video Solution

26. A body floats in a liquid fully submerged. If the body is pressed slightly downwards and then released, it will

A. oscillate up and down

B. remain at rest in its new position

C. return to the previous position quickly

D. return to the previous position slowly

Answer: B

View Text Solution

27. A bird is sitting on the floor of a wire cage. This cage is carried by a boy. In this situation, if the bird starts flying inside the cage, then the boy will feel that

A. the cage has become heavier than before

B. the cage has become lighter than before

C. the weight of the cage remains the same as before

D. the cage appears lighter first and then heavier

Answer: B

View Text Solution

28. A boat of length 3m and breadth 2m is floating on water in a lake. When a man rides on the boat, it sinks 1 cm more. The mass of the man is

A. 60 kg

B. 72 kg

C. 12 kg

D. 128 kg

Answer: A

Watch Video Solution

29. A wooden block is floating on water in a closed vessel. If the entire space above the water is evacuated, then

A. the block floats up more

B. the block sinks more

C. the block will remain in the same position

D. none of the above

Answer: B

Watch Video Solution

30. A body is floating on a liquid. The upthrust by the liquid acting on the body is

A. equal to the weight of the displaced liquid

B. zero

C. less than the weight of the displaced liquid

D. weight of the body - weight of the displaced liquid

Answer: A

 Watch Video Solution

31. A block of wood and a solid lead sphere are kept in a container with water up to its brim. Now,

if the lead sphere is placed on the floating block of wood, then the level of water

A. will remain the same

B. will fall

C. will rise and some water will overflow from the container

D. will change depending on the shape of the lead sphere

Answer: C

View Text Solution

32. Two solid pieces one of steel and other of aluminium when immersed completely in water have equal weights. When the solid pieces are weighed in air

A. the weight of aluminium is half the weight of steel

B. steel piece will weigh more

C. they have the same weight

D. aluminium piece will weigh more

Answer: D

Watch Video Solution

33. A man is sitting on a boat in a pond. If the man drinks some water from the pond, the level of water in the pond

A. will remain the same

B. will fall

C. will rise

D. will rise or fall depending on the amount of water drunk by the man

Answer: A

Watch Video Solution

34. A piece of ice is floating on a liquid of density $1.5g \cdot cm^{-3}$ kept in a beaker. If the piece of ice melts completely, then the liquid level in the beaker

A. will rise

B. will fall

C. will remain the same

D. will fall down first and then return to the original level

Answer: A

Watch Video Solution

35. A wooden block of mass 120 kg floats on water. The density of the wooden block is $600kg \cdot m^{-3}$. The weight that should be placed on the wooden block so that it just sinks will be

A. 80 kg

B. 50 kg

C. 60 kg

D. 30 kg

Answer: A

Watch Video Solution

36. A body with a uniform cross-section floats on a liquid. The density of the liquid is thrice the density of the body. The part of the body that remains above the liquid is

A. $\frac{2}{3}$

B. $\frac{5}{6}$

C. $\frac{1}{6}$

D. $\frac{1}{3}$

Answer: A

Watch Video Solution

37. A body remains floating in a liquid with a part of it immersed in the liquid. If the body along with the liquid is taken to the moon, then the body

A. will remain floating as before

B. will remain floating with a greater part of it inside the liquid than before

C. will remain floating with a lesser part of it inside the liquid than before

D. will sink in the liquid

Answer: A

Watch Video Solution

38. With increase in temperature, the upthrust acting on a body immersed in a liquid

A. increases

B. decreases

C. remains unchanged

D. none of these

Answer: B

 Watch Video Solution

39. A block of wood of mass m and density ρ is tied with a thread and rigidly fixed at the bottom of a vessel. The vessel is filled with a liquid of

density $\sigma(\sigma > \rho)$. The tension acting on the string is

A. $\left(\frac{\sigma - \rho}{\sigma}\right)mg$

B. $\left(\frac{\sigma - \rho}{\rho}\right)mg$

C. $\frac{\rho}{\sigma}mg$

D. $\frac{\sigma}{\rho}mg$

Answer: B

Watch Video Solution

Very Short Answer Type Questions

1. On what other factor does the pressure at a point in a liquid depend besides the depth of that point and the acceleration due to gravity at that place?

Watch Video Solution

2. The pressure at all points on the same horizontal plane inside a liquid are equal' - is the statement true or false?

Watch Video Solution

3. If two immiscible liquids in a U-tube are in equilibrium, then how are the heights of the two liquids from the surface of separation related with the densities of the two liquids?

Watch Video Solution

4. Besides the volume of the immersed part of a body in a liquid and acceleration due to gravity, on what factor does the buoyancy acting on a body depend?

Watch Video Solution

5. For a body floating partly immersed in a liquid, state whether the density of the body will be greater or less than the density of the liquid.

Watch Video Solution

6. A liquid does not undergo change in density due to change in pressure.' State whether the statement is true of false.

Watch Video Solution

7. Density of a substance = specific gravity of a substance $\times$ density of _____. [Fill in the blank]

Watch Video Solution

8. In all system of unit, the value of specific gravity is _____. [Fill in the blank]

Watch Video Solution

9. The density of the material of a body in its weightless condition remains _____. [Fill in the

blank]

Watch Video Solution

10. If the density of a body is more than the density of a liquid, then the body sinks in that liquid.' - State whether the statement is true or false?

Watch Video Solution

11. The weight of a body in air is 100 g and its weight in water is 40 g. Find the volume of the

body.

Watch Video Solution

12. Which quantity represents the normal force applied on unit area of a surface?

Watch Video Solution

13. Is pressure a vector quantity?

Watch Video Solution

14. Write down the variation of the pressure at a point in a liquid to its density.

Watch Video Solution

15. During the construction of a dam, the base of the dam wall is usually made wider.' - Correct or incorrect?

Watch Video Solution

16. Due to the upthrust of a liquid, a body immersed in the liquid suffers an apparent _____ in

weight. [Fill in the blank]

Watch Video Solution

17. Standard atmospheric pressure is equal to pressure exerted by _____ cm of mercury column. [Fill in the blank]

Watch Video Solution

18. What is the height of homogeneous column of air?

Watch Video Solution

19. Does a hydraulic press work if the liquid in it is replaced by a gas?

Watch Video Solution

20. What is the name of the upward force exerted by displaced liquid or gas on a body when it is partly or totally immersed in it?

Watch Video Solution

21. Does buoyancy depend on the depth up to which a body is completely immersed in a liquid?

Watch Video Solution

22. What fraction of floating ice remains below the surface of water?

Watch Video Solution

23. In which direction does the buoyant force act?

Watch Video Solution

24. What is the dimension of buoyancy?

Watch Video Solution

25. Name the principle which is effective in a hydraulic press.

View Text Solution

26. Thrust = pressure $\times$ _____. [Fill in the blank]

Watch Video Solution

27. In the tilted position of a floating body, the point at which the vertical line drawn through the centre of buoyancy cuts the central line, name the point of the body.

View Text Solution

28. Due to the upthrust of a liquid, the weight of a body immersed in that liquid decreases or increase?

Watch Video Solution

29. 1 torr = _____ $dyn \cdot cm^{-2}$ [Fill in the blank]

Watch Video Solution

30. Is Archimedes' principle applicable in the case of a freely-falling body?

Watch Video Solution

31. Is Archimedes' principle applicable inside an artificial satellite revolving around the earth?

Watch Video Solution

32. A boat floating in a pond is carrying a number of stones. If the stones are dropped into the pond, will the water level rise or fall?

Watch Video Solution

33. Does Archimedes' principle hold good in the case of a gas?

Watch Video Solution

34. State whether a lump of iron floats or sinks in mercury.

Watch Video Solution

35. Where does the centre of buoyancy lie in a displaced liquid.

View Text Solution

36. If the weight of a body is greater than the weight of the liquid displaced by it, then the body

_____ in that liquid. [Fill in the blank]

Watch Video Solution

37. What is the apparent weight of a floating body?

Watch Video Solution

38. When a ship enters a river from the sea. What will you find?

Watch Video Solution

39. A wooden block is floating on water in a closed vessel. If the air in the vessel is compressed, then the block will _____ more. [Fill in the blank]

Watch Video Solution

40. State whether the weight of a body measured in air will be more or less than its weight in vacuum.

Watch Video Solution

Short Answer Type Questions I

1. Which is easier to lift in the air - 1kg of steel or 1 kg of wool?

Watch Video Solution

2. Why can burning petrol not be extinguished by pouring water over it?

Watch Video Solution

Short Answer Type Questions Ii

1. A solid glass cube is placed at the bottom of a container. When the container is filled with mercury, it is seen that no displacement of the glass cube occurs. Explain why.

Watch Video Solution

2. A hollow glass sphere, containing atmospheric air, is weighed in air with the help of a balance. The sphere is then broken into pieces and the broken pieces are weighed again in air. Will there be any difference in the two weights? (Assume

that the air pressure inside the sphere was equal to the external atmospheric pressure)

Watch Video Solution

3. Two closed containers of equal weight and size are to be dipped into water up to the same depth. There is a hole at the bottom of one of the containers through which water can enter it. For which container, more work has to be done?

Watch Video Solution

4. Two balloons of equal weight and volume are filled with hydrogen gas. One of the balloons is made of rubber while the other is made of incompressible polythene. If hydrogen gas does not leak from either balloon, then which balloon will rise higher?

Watch Video Solution

Problem Set I

1. The specific gravity of silver is 10.5. Calculate the density of silver in the CGS system and in SI.

Watch Video Solution

2. The mass and volume of an alloy made of copper and lead are 320 g and $30cm^3$ respectively. Calculate the volumes of copper and lead present in it. The specific gravities of copper and lead are 8.89 and 11.37 respectively.

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3. A container has 90 g sulphuric acid of specific gravity 1.8. If 90g of water is mixed it, then what will be the contraction in volume during the preparation of the mixture? [specific gravity of the mixture = 1.5]

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4. A body of mass 300 g is floating in saline water with half of the body outside. What are the volume and density of the material of that body? [Density of saline water = $1.03g \cdot cm^{-3}$]

Watch Video Solution

Watch Video Solution

5. A ring made of diamond and gold weighs $5g \times g$ in air and $4.6g \times g$ in water. The specific gravities of gold and diamond are 19.3 and 3.5 respectively. Determine the mass of diamond.

Watch Video Solution

6. An iceberg is floating on sea water. What part of it remains above water? The densities of ice and sea water are $0.918g \cdot cm^{-3}$ and $1.03g \cdot cm^{-3}$ respectively.

Watch Video Solution

7. A piece of iron is floating in mercury. If $\frac{5}{9}$ part of the piece remains below mercury, then what will be its density? The density of mercury = $13.59g \cdot cm^{-3}$

Watch Video Solution

8. 0.2 part of the volume of a body floating in a liquid remains exposed to air. In water, 0.1 part of

that floating body remains exposed to the outside air. Calculate the density of the liquid.

Watch Video Solution

9. The height of a water-filled conical vessel is 0.5 m, the area of its base is $20 \times 10^{-4} m^2$. The vessel is placed on its base upon a table. Find the thrust of water on the table.

Watch Video Solution

10. A beaker contains mercury to a depth of 4 cm and above it there is water of depth 12 cm. What is the total pressure acting on the bottom of the beaker? [density of mercury = $13.6g \cdot cm^{-3}$, atmospheric pressure = 76 cm of mercury]

Watch Video Solution

11. If the atmospheric pressure is $10^5 N \cdot m^{-2}$, then, at what depth below water, will the pressure exerted by water be 3 times the atmospheric pressure?

Watch Video Solution

12. The pressure of water of a tap on the ground floor of a building is $590000N \cdot m^{-2}$ and that of a tap on the top floor of the building is $198000N \cdot m^{-2}$. Determine the height of the building.

Watch Video Solution

13. The diameters of the smaller and the larger pistons of a hydraulic press are 5 cm and 45 cm respectively. What force should be applied on the

smaller piston of the press, so that the thrust developed on the larger piston is 39690 N?

Watch Video Solution

14. The lengths of the two arms of a first class lever used in a hydraulic press are 20 cm and 100 cm. The radii of the larger and the smaller pistons are 30 cm and 3 cm respectively. If a force of 196 N is applied at the handle of the lever, then what thrust will be developed on the larger piston?

Watch Video Solution

15. The diameters of the two pistons of a hydraulic pressare 8 cm and 80 cm. The smaller piston is attached at a distacne of 60 cm from the fulcrum of the lever whose total length is 360 cm. To develop a thrust of 49 N on the larger piston, what force should be applied at the handle of the lever?

Watch Video Solution

16. The ratio of the diameters of the smaller and the larger pistons of a hydraulic press is 1 : 5. The

ratio of the lengths of the arms of the lever used is 1 : 8. If a force of 490 N is applied at the handle of the lever, then how much thrust will be developed on the larger pistion?

Watch Video Solution

17. The ratio of the diameters of the two pistons in a hydraulic press is 16 : 3 and the ratio of the lengths of the arms of a first class lever used in it is 9 : 4. What is the mechanical advantage of the press?

Watch Video Solution

18. The area of the piston of a lift pump is $20cm^2$. How much force should be applied to lift water up to a height of 300 m with the help of that pump?

Watch Video Solution

19. The density of a body is d and that of air is ρ. Prove that the real weight of the body, weighed W in air, is $W_0 = \frac{W}{1 - \rho/d}$.

Watch Video Solution

20. The mass of a body is 200g. Keeping $\frac{9}{17}$ part of its volume exposed to air, the body is floating in mercury. If the specific gravity of mercury is 13.6, then what will be the specific gravity of the body?

Watch Video Solution

21. The volume of a piece of floating wax is $22cm^3$. $20cm^3$ of its volume is in water. Determine the mass and specific gravity of the piece of wax.

Watch Video Solution

22. The cross-sectional area of a cylinder is $4cm^2$. It floats vertically in water and alcohol with 8 cm and 10 cm immersed respectively. Determine the mass of the cylinder and the density of alcohol.

View Text Solution

23. A metallic sphere of volume $2000cm^3$ contains a cavity of volume $1720cm^3$ inside it. A force of 1960 dyn is required to immerse the sphere completely in water. What is the density of the metal?

View Text Solution

24. A body of mass 4 kg and density $2.5g \cdot cm^{-3}$ is suspended with a metallic wire of length 1 m and diameter 2 mm. If the body is totally immersed in water, what will be the elongation of the wire? Young's modulus of the metal = $2 \times 10^{11} N \cdot m^{-2}$ and $g = 9.8m \cdot s^{-2}$

View Text Solution

25. The mass of a capillary tube is 4.576 g. If a mercury thread is introduced into the tube, it

weighs 4.925 g. If the length of this mercury thread is 3.435 cm, then determine the average diameter of the bore of the capillary tube. [specific gravity of mercury = 13.6]

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26. In a cistern there is water up to a depth of 1.2 m. There is a circular hole of diameter 1 cm at the bottom of the cistern. To stop the flow of water through this hole, what force should be applied on the hole?

Watch Video Solution

27. The area of the bottom of a water-filled bottle is $20cm^2$. The mouth of the bottle is corked and the area of the cork is $1cm^2$. If a force of 0.49 N is applied on the cork, then what thrust will be exerted on the bottom of the bottle?

Watch Video Solution

28. Suspended from a thread, a piece of iron of mass 160 g remains immersed completely in

water. If the specific gravity of iron is 8, calculate the tension in the thread.

Watch Video Solution

29. The density of the material of an idol is $10.5g \cdot cm^{-3}$. The mass of the idol is 400 g and it weighs $358g \times g$ when completely immersed in water. Determine the volume of the cavity inside the idol.

Watch Video Solution

Problem Set Ii

1. A rectangular vessel of length, breadth and depth 4m, 3m and 2m respectively is completely filled with water. What will be the thrust actine on two adjacent faces of the vessel?

Watch Video Solution

2. The width of the lock-gate of a canal is 3m. On one side, the depth of water is 4.5m and on the other side the depth is 3m. Determine the

resultant thrust exerted by the water on the lock-gate.

Watch Video Solution

3. A conical-shaped container with a base diameter of 30 cm and a height of 40 cm is completely filled with a liquid. If the density of this liquid is $1.03g \cdot cm^{-3}$, then determine the mass of the liquid in it and the thrust developed on the base of the cone.

Watch Video Solution

4. A tank having a base area of $20m^2$ and a height of 5 m is half-filled with water and the remaining half is filled with a liquid of density $0.86g \cdot cm^{-3}$. Calculate the total thrust exerted at the bottom of the tank. $[g = 10m \cdot s^{-2}]$

Watch Video Solution

5. There is some mercury in a U-tube. Water is poured into one of its arms and kerosene into the other. When the heights of the water and the kerosene oil are 4cm and 5cm respectively, the

level of mercury in both the arms becomes the same. Calculate the density of kerosene oil.

Watch Video Solution

6. Mercury is poured into a U-tube of uniform bore such that the level of mercury remains 20 cm below the open ends in both arms. Now, one arm is filled completely with water and the other arm with kerosene. Calculate the lengths of the water column and the kerosene column. The specific gravities of kerosene and mercury are 0.8 and 13.6 resspectively.

Watch Video Solution

7. A U-tube of uniform bore containing paraffin oil in one limb and water in the other is placed vertically on a table. The top and the bottom of the paraffin oil column from the table are respectively at heights of 18.4 cm and 6.4 cm. The top of the water column is 16.6 cm above the table. Calculate the specific gravity of paraffin oil.

Watch Video Solution

8. The cross-sectional area and length of each arm of a U-tube are $1cm^2$ and 33 cm respectively. Mercury is poured into it up to a height of 6.8 cm in each arm. Now water is poured into one of the arms to fill it completely. If the density of mercury is $13.6g \cdot cm^{-3}$, then determine the volume of water poured into it.

Watch Video Solution

9. The cross-sectional areas of the two arms of a U-tube are $1cm^2$ and $0.1cm^2$ respectively. Some

water is poured inside the tube. How much liquid of density $0.85g \cdot cm^{-3}$ should be poured into the wider limb so that water rises by 15 cm in the narrow limb?

Watch Video Solution

10. A U-tube of uniform cross-section contains some water. When $4cm^3$ of water is poured into it, the water level rises by 1 cm in each arm of the tube. Now if $10cm^3$ of oil is poured through one of the limbs, the water level rises further by 2.2 cm in the other limb. Calculate the density of the oil.

Watch Video Solution

11. A mass of 1000 kg is to be raised with the help of a hydraulic press. The ratio of the diameters of its pistons is 1 : 5 and the mechanical advantage of the press is 4. What force has to be applied on the smaller piston of the press?

Watch Video Solution

12. A hollow sphere of density $3.1g \cdot cm^{-3}$ is floating in a liquid of density $1.5g \cdot cm^{-3}$

remaining completely immersed in it. The external diameter of the sphere is 10 cm. Determine its internal diameter.

Watch Video Solution

13. The external and internal diameters of a hollow sphere are 6 cm and 8 cm respectively. The sphere floats completely immersed in a liquid of density $1.2g \cdot cm^{-3}$. What is the density of the material of the sphere?

Watch Video Solution

14. By means of a hydrostatic balance, it is found that an iron cylinder and a glass cylinder of equal radii, when completely immersed in water, balance each other. If the specific gravities of iron and glass are 7.2 and 2.55 respectively, then determine the ratio of the lengths of the two cylinders.

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15. A piece of cork of density $0.25g \cdot cm^{-3}$, attached to a metal piece of mass 10 g and of density $5g \cdot cm^{-3}$, is found to float completely

immersed in water. Determine the volume of the piece of cork.

Watch Video Solution

16. When a body of mass 200 g is placed on a wooden cube, the cube floats completely immersed in water. When the body is removed, the cube floats up 2 cm above the surface of the water. What is the volume of the cube?

Watch Video Solution

17. When a piece of cork of specific gravity 0.25 is tied with a metal piece of specific gravity 8, the combination is found neither to float nor to sink in alcohol of specific gravity 0.8. What is the ratio of the masses of the piece of cork and the piece of metal?

Watch Video Solution

18. What should be the minimum area of an ice block of thickness 30 cm so that it can float on

water with a man of mass 90 kg on it? The density of ice = $0.9g \cdot cm^{-3}$.

Watch Video Solution

19. A metallic sphere of radius 4 mm sinks in water. If it is coated with wax of a uniform thickness of 3 mm, it can just float in water. If the density of wax is $0.8g \cdot cm^{-3}$, then what will be the density of the metal?

Watch Video Solution

20. A vessel contains mercury and water. An iron cylinder just floats vertically in that vessel. What is the ratio of the immersed parts of the cylinder in water and in mercury? The density of mercury = $13.6g \cdot cm^{-3}$ and the density of iron = $7.78g \cdot cm^{-3}$.

Watch Video Solution

21. A string can withstand a maximum tension of $3kg \times g$. A stone of mass 3.5 kg is suspended in water by the string. What part of the stone

should be drawn out of the water bu pulling the string so that the string snaps?

The specific gravity of stone = 1.5.

Watch Video Solution

22. Two bodies of identical size but made of different materials remain immersed completely in water. One of them remains suspended with the help of a thread and the tension acting on that thread is $500g \times g$. The other is anchored to the bottom of the vessel by a thread so that it cannot float up and the tension acting on this

thread is $12.5g \times g$. If the volume of each body is $50cm^3$, then determine the mass and density of each body.

Watch Video Solution

23. A hollow spherical glass ball sinks in spirit (density $0.8g \cdot cm^{-3}$) remaining immersed just below the surface of the spirit. What will be the immersed fraction when the ball floats on sulphuric acid? [Density of sulphuric acid = $1.8g \cdot cm^{-3}$]

Watch Video Solution

24. When a body is put into three liquids in succession, it floats with $\frac{1}{2}, \frac{1}{3}$ and $\frac{1}{4}$ of its volume immersed in the three liquids respectively. If the body is put into a mixture of these liquids, mixed in equal volumes, what fraction of its volume will remain under the liquid?

Watch Video Solution

25. The weights of a body in air and water are W and W' respectively. Prove that the apparent

weight of the body when immersed in a liquid of density δ will be $W'' = W - (W - W')\delta$.

Watch Video Solution

26. A body floats on a liquid of specific gravity S_1 with f part of it immersed in that liquid. It also floats on another liquid of specific gravity S_2 with (1 - f) part of it immersed. Prove that the specific gravity of the body = $\frac{S_1 S_2}{S_1 + S_2}$.

Watch Video Solution

27. When a body floats in a liquid, x part of its volume remains exposed to air. If the body is immersed completely inside the liquid and then released, what will be the upward acceleration of the body?

Watch Video Solution

28. The density of the material of a body is $0.76g \cdot cm^{-3}$ and its weight in air is $40g \times g$. If the density of the material of the counterpoising weight if $8.4g \cdot cm^{-3}$ and the density of air is

$1.293g \cdot L^{-1}$, then what is the real weight of the body?

View Text Solution

29. There is a cavity of radius r present in a sphere made of concrete of radius R. The cavity is filled with sawdust. The sphere floats just immersed in water. The specific gravities of concrete and sawdust are 2.4 and 0.3 respectively. What is the ratio of the masses of concrete and sawdust?

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30. Two bodies weigh the same when measured in water. The mass of one is 30 g and its specific gravity is 6. If the mass of the other body is 45g, then what will be its specific gravity?

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31. The volume and mass of a buoy are 1000 L and 950 kg respectively. It is anchored to the bottom of the sea with a light chain which keeps it floating inside the water. The specific gravity of sea water is 1.02. What is the tension in the chain?

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32. A piece of cork (density $0.8g \cdot cm^{-3}$) is placed at the bottom of water. If now the cork is released, then prove that it will rise upwards with an acceleration of $\frac{g}{4}$.

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Hots Numerical Problems

1. A U-tube is partly filled with water. A liquid, immiscible in water, is poured into one arm until the level of the liquid comes to a height h above the water level in the other arm. The water in the second arm is at a height d above its previous level in this arm. Calculate the density of the liquid.

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2. A U-tube is almost half-filled with mercury. The wider limb has an area of cross-section of $2cm^2$,

and the cross-section of the narrow limb is $1cm^2$. If $52cm^3$ of water is poured into the wider limb, then what will be the depression of the mercury level in that limb? The density of mercury = $13.6g \cdot cm^{-3}$.

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3. A body floats on a liquid with n-part of its volume immersed in the liquid. The body is released at a depth d inside the liquid. Show that it will reach the surface after a time $\sqrt{\frac{2(1-n)d}{ng}}$

.

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4. A vessel contains some oil of specific gravity 0.6 on water in it. The upper surface of a wooden block, having each side 10 cm, remains floating completely immersed in oil. The lower surface of the block remains 2 cm below the surface of water. Determine the mass of the wooden block

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5. A man along with a lump of stone is on a floating boat in a swimming pool of length 10 m and breadth 5 m. The mass of the stone is 40 kg and its specific gravity is 3. If the man drops the stone from the boat into the water, then what will be the rise or fall in the water level of the pool?

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6. Each side of an iron cube is 5 cm. This cube floats on mercury. What height of the cube remains above the surface of mercury? To cover

the cube, if water is poured over mercury, then what will be the height of the water column? The density of iron is $7.2g \cdot cm^{-3}$ and the density of mercury is $13.6g \cdot cm^{-3}$.

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7. A body floats in a liquid with $\frac{1}{4}$th of its volume above the liquid. If the body is released at a depth d inside the liquid, show that it takes time of $\sqrt{\frac{6d}{g}}$ to reach the surface.

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8. A sphere made of rubber of specific gravity ρ is released at a depth h inside a liquid of specific gravity $\sigma(\rho < \sigma)$. How much above the surface of the liquid will the sphere jump? Neglect all types of resisting force.

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9. A flat-bottomed glass tube has a diameter of 4 cm and weighs $30g \times g$. The centre of gravity of the empty tube is 10 cm above the bottom. Find the amount of water which must be poured into

the tube so that when it is floating vertically in a tank of water, the centre of gravity of the system is at the mid-point of the immersed length of the tube.

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10. A cubical wooden block of side 3 cm floats on water kept in a vessel. The lower face of the cube just touches the free end of a vertical spring fixed at the bottom of the vessel. Find the maximum weight that can be put on the block so that the weight does not touch water. The specific gravity

of wood = 0.8 , the force constant of the spring = $50N \cdot m^{-1}$ and $g = 10m \cdot s^{-2}$.

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11. The pressure at the bottom of a well is four times that at a point 2.5 m below its top. If the atmospheric pressure is equal to the pressure of 10 m of a water column, then what is the depth of the well?

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12. The mouth of a bottle is corked and through it a hollow tube is inserted. The bottle and some part of the tube is filled with mercury. If $1cm^3$ of mercury is poured into the tube, then what will be the increase in the thrust on the bottom of the bottle? Diameter of the bottom of the bottle is 12 cm and the internal diameter of the tube is 6mm.

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13. The height of a cylindrical tank is 0.4 m. The upper end of it open whose diameter is 0.16 m. It

contains water up to a height of 0.16m. How much would be the time required to empty the tank through a hole of radius 10^{-3} m at the bottom of the tank?

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14. A rubber ball of radius R and mass m is released at a depth h below the surface of water. How much above the suface of water will the ball rise? [Neglect all types of obstruction]

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15. A large block of ice 5 m thick has a vertical hole drilled through it and is floating in the middle of a lake. What is the minimum length of a rope required to lift up a bucket full of water through the hole? The density of ice is $0.9g \cdot cm^{-3}$.

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16. The volume and mass of a hydrogen gas balloon are 1000 L and 1 kg respectively. The density of the material of a block is $91.3g \cdot L^{-1}$ and the density of air is $1.3g \cdot L^{-1}$. Find the

maximum volume of the block that can be raised by the bolloon?

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17. A vertical off-shore structure is built to withstand a maximum stress of 10^9Pa. Is the structure suitable for putting up on top of an oil well in the ocean? Take the depth of the ocean to be roughly 3 km and ignore ocean currents.

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18. A tank with a square base of area $1.0m^2$ is divided by a vertical partition in the middle. The bottom of the partition has a small-hinged door of area $20cm^2$. The tank is filled with water in one compartment, and an acid (of relative density 1.7) in the other, both to a height of 4.0 m. Compute the force necessary to keep the door closed.

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19. During blood transfusion the needle is inserted in a vein where the gauge pressure is

2000 Pa. At what height must the blood container be placed so that blood may just enter the vein? The density of whole blood is $1.06 \times 10^3 kg \cdot m^{-3}$.

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20. The diameter and height of a narrow cylindrical vessel are 10 cm and 15 cm respectively. The vessel contains $200 cm^3$ of water and the mass of the vessel is 114 g. The vessel is then placed inside a large vessel and water is poured into it. For what maximum level-height of water in

the large vessel, will the cylindrical vessel just float up?

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21. A uniform rod of density ρ is placed in a wide tank containing a liquid of density $\rho_0 (\rho_0 > \rho)$. The depth of liquid in the tank is half the length of the rod. The rod is in equilibrium, with its lower end resting on the bottom of the tank. In this position the rod makes an angle θ with the horizontal. Determine θ.

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Entrance Corner Assertion Reason Type

1. Statement I : If a barometer is accelerated upwards, the level of mercury in the tube of the barometer will decrease.

Statement II : The effective value of g will increase, so upthrust will increase.

A. Statement I is true, statement II is true , statement II is a correct explanation for statement I.

B. Statement I is true, statement II is true , statement II is not a correct explanation for statement I.

C. Statement I is true, statement II is false.

D. Statement I is false, statement II is true.

Answer: B

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2. Statement I : A hydrogen-filled balloon stops rising after it has attained a certain height in the

sky.

Statement II : The atmospheric pressure decreases with height and becomes zero when maximum height is attained.

A. Statement I is true, statement II is true , statement II is a correct explanation for statement I.

B. Statement I is true, statement II is true , statement II is not a correct explanation for statement I.

C. Statement I is true, statement II is false.

D. Statement I is false, statement II is true.

Answer: C

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3. Statement I : A solid sphere and a hollow sphere of same material are floating in a liquid. Radius of both spheres are same. Percentage of volume immersed of both the spheres wil be same.

Statement II : Upthrust acts on volume of liquid

displaced. It has nothing to do with whether the body is solid or hollow.

A. Statement I is true, statement II is true , statement II is a correct explanation for statement I.

B. Statement I is true, statement II is true , statement II is not a correct explanation for statement I.

C. Statement I is true, statement II is false.

D. Statement I is false, statement II is true.

Answer: D

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4. Statement I : For a floating body to be in stable equilibrium, its centre of buoyancy must be located above the centre of gravity.

Statement II : The torque developed by the weight of the body and the upthrust will restore the body back to its normal position, after the body is disturbed.

A. Statement I is true, statement II is true , statement II is a correct explanation for statement I.

B. Statement I is true, statement II is true , statement II is not a correct explanation for statement I.

C. Statement I is true, statement II is false.

D. Statement I is false, statement II is true.

Answer: D

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5. Statement I : The blood pressure in humans is greater at the feet than that at the brain.

Statement II : Pressure of liquid at any point is proportional to height, density of liquid and acceleration due to gravity.

A. Statement I is true, statement II is true , statement II is a correct explanation for statement I.

B. Statement I is true, statement II is true , statement II is not a correct explanation for statement I.

C. Statement I is true, statement II is false.

D. Statement I is false, statement II is true.

Answer: A

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6. Statement I : A cylinder fitted with a movable piston contains a certain amount of liquid in equilibrium with its vapour. The temperature of the system is kept constant with the help of a thermostat. When the volume of the vapour is decreased by moving the piston inwards, the

vapour pressure does not increase.

Statement II : Vapour in equilibrium with its liquid, at a constant temperature, does not obey Boyle's law.

A. Statement I is true, statement II is true , statement II is a correct explanation for statement I.

B. Statement I is true, statement II is true , statement II is not a correct explanation for statement I.

C. Statement I is true, statement II is false.

D. Statement I is false, statement II is true.

Answer: A

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7. Statement I : A body floats in a liquid with a fraction n of its volume above the surface of the liquid. If the system is taken to a planet where the acceleration due to gravity is greater than that on earth, the fraction n will decrease.

Statement II : For flotation, the weight of the body is equal to the weight of the liquid displaced.

A. Statement I is true, statement II is true , statement II is a correct explanation for statement I.

B. Statement I is true, statement II is true , statement II is not a correct explanation for statement I.

C. Statement I is true, statement II is false.

D. Statement I is false, statement II is true.

Answer: D

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Multiple Correct Answers Type

1. A spring balance A reads 2 kg with a block suspended from it. Another balance B reads 5 kg when a beaker with liquid is put on the pan of the balance. When the block is immersed in water

A. the balance A will read more than 2 kg

B. the balance B will read more than 5 kg

C. the balance A will read less than 2 kg

D. the balance A will read 2 kg and the balance B will read 5 kg

Answer: B::C

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2. A closed vessel is half filled with water. There is a hole near the top of the vessel and air is pumped out from this hole. As a result

A. the water level will rise up in the vessel

B. the pressure at the surface of the water will decrease

C. the force by the water on the bottom of the vessel will decrease

D. the density of the liquid will decrease

Answer: B::C

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3. When a body of density ρ and volume V is floating in a liquid of density σ

A. its true weight is $V\rho g$

B. loss in its weight is $V\sigma g$

C. its apparent weight is zero

D. its density ρ is less than that of liquid σ

Answer: A::C::D

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4. A wire is found to have a length L when it is loaded with a block of mass M and relative density n. When the block is immersed in water, the length of the wire reduces by x, then

A. weight of water displaced when the block is immersed in water is $\frac{Mg}{n}$

B. the apparent loss of weight due to immersion is $Mg\left(1-\frac{1}{n}\right)$

C. the original length of the wire before it was loaded is $L_1 = L - nx$

D. the original length of the wire before it was loaded is $L_1 = L - \frac{x}{n}$

Answer: A::B::C

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Comprehension Type

1. An engineering firm is assigned the job to design the cylindrical pressured water tank for a future colony on Mars, where the acceleration due to gravity is $3.71m \cdot s^{-2}$. The pressure at the surface of the water will be 130 kPa and depth of the water will be 14.2 m. The pressure of the air in the building outside the tank will be 93 kPa.

Find the net downward force on the tank's flat bottom of area $2m^2$

A. 179.4 kN

B. 365.4 kN

C. 105.36 kN

D. none

Answer: A

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2. An engineering firm is assigned the job to design the cylindrical pressured water tank for a future colony on Mars, where the acceleration due to gravity is $3.71m \cdot s^{-2}$. The pressure at the surface of the water will be 130 kPa and depth of

the water will be 14.2 m. The pressure of the air in the building outside the tank will be 93 kPa.

What is the buoyant force on a wooden block of mass 2 kg and relative density 0.8, height 10 cm?

A. 5.94 N

B. 7.42 N

C. 1.48 N

D. none

Answer: B

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Integer Answer Type

1. A cylinder has radius 8 cm. Up to what height (in cm) should it be filled with water so that the thrust on its walls is equal to that on its bottom?

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2. Mass of a balloon with its contents is 1.5kg. It is descending with an acceleration equal to half of acceleration due to gravity. If it is to go up with the same acceleration keeping the volume same,

what amount of mass (in kg) should be decreased?

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3. A ball whose density is $0.4 \times 10^3 kg \cdot m^{-3}$ falls into water from a height of 9 cm. To what depth does the ball sink?

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4. A water tank is 20 m deep. If a water barometer reads 10 m at that place, then what is the

pressure (in SI unit) at the bottom of the tank in atmosphere?

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Examination Archive

1. Explain the working principle of hydraulic press using Pascal's law.

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2. What is buoyancy? On what factors do it depend?

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3. The density of a body is d and that of air is ρ. If the body weighs w in air, what will be its actual weight?

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4. How is the law of multiplication of thrust (force) obtained from the Pascal's law?

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5. Does the principle of multiplication of thrust violate the principle of conservation of energy? Discuss.

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6. What are the SI units of thrust and pressure?

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7. A drop of oil rises through water with an acceleration αg. If α is a constant quantity and g is the acceleration due to gravity, find the specific gravity of the oil. Neglect the friction of water.

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Wbjee

1. A uniform rod is suspended horizontally from its mid-point. A piece of metal whose weight is W is suspended at a distance l from the mid-point. Another weight W_1 is suspended on the other side at a distance l_1 from the mid-point to bring the rod to a horizonatl postion. When W is completely immersed in water, W_1 needs to be kept at a distance l_2 from the mid-point to get the rod into horizontal postion. The specific gravity of the metal piece is

A. $\frac{W}{W_1}$

B. $\frac{Wl_1}{Wl - W_1 l_2}$

C. $\frac{l_1}{l_1 - l_2}$

D. $\frac{l_1}{l_2}$

Answer: C

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2. A wooden block is floating on water kept in a beaker. 40% of the block is above the water surface. Now the beaker is kept inside a lift that starts going upward with acceleration equal to g/2. The block will then

A. sink

B. float with 10% above the water surface

C. float with 40% above the water surface

D. float with 70% above the water surface

Answer: C

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3. To determine the composition of a bimetalic alloy, a sample is first weighed in air and then in water. These weights are found to be w_1 and w_2

respectively. If the densities of the two constituent metals are p_1 and p_2 respectively, then the weight of the first metal in the sample is (where ρ_w is the density of water)

A. $\frac{\rho_1}{\rho_w(\rho_2-\rho_1)}[w_1(\rho_2-\rho_w)-w_2\rho_2]$

B. $\frac{\rho_1}{\rho_w(\rho_2+\rho_1)}[w_1(\rho_2-\rho_w)+w_2\rho_2]$

C. $\frac{\rho_1}{\rho_w(\rho_2-\rho_1)}[w_1(\rho_2+\rho_w)-w_2\rho_1]$

D. $\frac{\rho_1}{\rho_w(\rho_2-\rho_1)}[w_1(\rho_2-\rho_w)-w_2\rho_1]$

Answer: A

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4. A hollow sphere of external radius R and thickness $t(<<R)$ is made of a metal of density ρ. The sphere will float in water if

A. $t \leq \frac{R}{\rho}$

B. $t \leq \frac{R}{3\rho}$

C. $t \leq \frac{R}{2\rho}$

D. $t \geq \frac{R}{3\rho}$

Answer: B

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5. A cylinder of height h is filled with water and is kept on a block of height h/2. The level of water in the cylinder is kept constant. Four holes numbered 1, 2, 3 and 4 are at the side of the cylinder and at heights 0, h/4, h/2 and 3h/4 respectively. When all four holes are opened together, the hole from which water will reach farthest distance on the plane PQ is the hole number

A. 1

B. 2

C. 3

D. 4

Answer: B

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6. There is a circular tube in a vertical plane. Two liquids which do not mix and of densities d_1 and d_2 are filled in the tube. Each liquid subtends 90° angle at centre. Radius joining their interface makes an angle α with vertical. Ratio

d_1 / d_2 is

A. $\frac{1+\sin\alpha}{1-\sin\alpha}$

B. $\frac{1+\cos\alpha}{1-\cos\alpha}$

C. $\frac{1+\tan\alpha}{1-\tan\alpha}$

D. $\frac{1+\sin\alpha}{1-\cos\alpha}$

Answer: C

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7. An open glass tube is immersed in mercury in such a way that a length of 8 cm extends above the mercury level. The open end of the tube is then closed and sealed and the tube is raised vertically up by additional 46 cm. What will be length of the air column above mercury in the tube now? (Atmospheric pressrure = 76 cm of Hg)

A. 16 cm

B. 22 cm

C. 38 cm

D. 6 cm

Answer: A

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8. Two non-mixing liquids of densities ρ and $n\rho(n > 1)$ are put in a container. The height of each liquid is h. A solid cylinder of length L and density d is put in this container. The cylinder floats with its axis vertical and length $pL(p < 1)$ in the denser liquid. The density d is equal to

A. $\{2 + (n + 1)p\}\rho$

B. $\{2 + (n - 1)p\}\rho$

C. $\{1+(n-1)p\}\rho$

D. $\{1+(n+1)p\}\rho$

Answer: C

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Cbse Scanner

1. Using Pascal's law, explain with a neat figure, the working of a hydraulic lift. Mention any one situation from your daily life where hydrostatic paradox is useful.

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