



PHYSICS

BOOKS - PEARSON IIT JEE

FOUNDATION

HYDROSTATICE

Example

1. At a given temperature, pressure of helium gas is 2Pa and its volume is 400 ml . Find

volume occupied by it at 1Pa.



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2. The area of cross section of two cylinders of a Bramah press are 10cm^2 and 50cm^2 , respectively. In order to move up a weight of 100 placed on the bigger piston. what force should be applied on the smaller piston of smaller area ?



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3. A car of mass 1400 kg placed on the platform in a service station has to be lifted up. The area of the press piston to which the platform is $5m^2$. Determine the force that has to be applied on the piston of pump cylinder having an area of cross section $0.25m^2$.

(Take $g = 10 \text{ m s}^{-2}$)



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4. In the previous example, calculate the mechanical advantage of the vehicle lifting

machine.



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5. The mass of a body is 2 kg and its volume is 250 cm^3 . Find its relative density.



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6. The specific gravity (or relative density) of gold is 19. Find the mass of a gold body that displaces 25 cm^3 of water when immersed in it.



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7. A body weights 75 gf in air, 51gf when completely immersed in a liquid and 67 gf when completely immersed in water. Find the density of the liquid



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8. A cylindrical body floats in water such that one-fourth of its volume lies above the surface

of water. Find the density of the material with which the body is made of.



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Test Your Concepts Very Short Answer Type Question

1. State Archimedes' principle.



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2. Mention a difference between a common hydrometer and a lactometer.



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3. A hydrometer is used to measure _____
of liquids.



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4. If relative density of a liquid is 2.3, what is its density in S.I. system ?



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5. State Pascal's law of transmission of fluid pressure.



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6. (a) What is a meniscus ?

(b) How many types of meniscus are there and what are they ?



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7. (a) What is the condition required so that a solid body sinks in a liquid ?

(b) When does it just in the liquid ?



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8. What is the expression for mechanical advantage of a hydraulic press ?



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9. Why does a liquid surface behave like a stretched membrane ?



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10. What is the condition required so that a solid body floats in a liquid with some part of the body above the surface of the liquid ?



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11. Mention two applications of Pascal's law of transmission of pressure.



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12. What is viscosity and what is meant by a viscous liquid ?



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13. Viscosity of liquids _____ with increase in temperature.



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14. On what principle does the hydraulic brakes in a vehicle work ?



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15. Define cohesive and adhesive force.



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16. Name the devices used to measure the density of a liquid.



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17. Define (i) atmospheric pressure (ii) one atmosphere.



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18. A container of filled with water to a height of 10 m.

The pressure exerted by the water at the bottom of the container is _____ .





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19. Define meta centre.



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20. Which instrument is used to measure atmospheric pressure ?



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21. What is surface tension ?



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22. State the law of floatation.



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23. Which barometer is generally used in laboratories to measure atmospheric pressure accurately ?



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24. Name the instrument that can check the recharging capacity of a car battery .



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25. What is the shape of liquid drops and what is the cause for their shape ?



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26. Which barometer does not contain any liquid ?



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27. On what factors does the fluid pressure depend ?



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28. If a cylindrical wooden piece of density 750 kg m^{-3} is floating in water, what fraction of the length of the cylinder is inside the water ?



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29. If an object floats in water such that half of its volume is immersed in it, then the density of the object is _____ kg m^{-3} .



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Short Answer Type Question

1. Explain the factors that affect barometric height.



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2. Derive an expression for the condition for a solid body immersed in a liquid to float in it.



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3. Mention the characteristics of floating body.



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4. Define capillarity and mention applications of it.



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5. What are the disadvantages of a simple mercury barometer ?



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6. Explain equilibria of a floating body.



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7. How does capillary action differ in water and mercury ?



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8. Explain the cause of upthrust on a body immersed in a liquid.



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9. What is a hydrometer ? Name the two categories of hydrometers and explain the principle on which its working is based.



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10. Differentiate between liquids and gases.



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11. Explain the verification of Archimedes' principle.



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12. What are the advantages of an aneroid barometer over a simple barometer ?



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13. Derive an expression for fluid pressure.



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Essay Type Question

1. Explain capillarity in detail.



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2. A block of wood floats in water such that half of its volume is below the water surface. But in a certain liquid, it floats with $(1/4)$ th of its volume below the liquid. Find the density of liquid.



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3. Explain why water has concave meniscus while mercury has convex meniscus when poured in a uniformly narrow glass tube ?



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4. The mechanical advantage of a hydraulic press is 5.

A car of mass 1500 kg is lifted by when placed on a piston of a hydraulic press of area of cross section 5 m^2 . Find the area of cross section of piston of piston where the effort is applied.



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5. Explain the phenomenon of viscosity in detail.



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Level 1 True Or False

1. Hydrometer work on the principle of 'Laws of floatation'.

A. True

B. False

C.

D.

Answer: True



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2. When one limb of a manometer is connected to a container filled with a gas, the level of the mercury in the other limb rises by

'h' cm. Then the pressure of the gas in the container is $76+h$ cm of Hg.



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3. The ratio of buoyant forces experienced by a solid body when immersed in two liquids whose relative densities are 1 and 0.5, respectively, is 2 : 1

A. True

B. False

C.

D.

Answer: 1



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4. The intermolecular forces of attraction are weaker in liquids when compared to those in solids.



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5. A body remains in neutral equilibrium when meta center coincides with the center of gravity.



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6. The net pressure acting at the bottom of a container filled with a liquid of density ' d ' to a height of h is hdg .



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7. Pressure of a gas enclosed in a container can be measured using a manometer.



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Level 1 Fill In The Blanks

1. At constant temperature, if the pressure of a gas of volume V in a container is doubled, the change in its volume is _____ .



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2. A wooden plank immerses upto 50% in water. Then _____ % of it is immersed in a liquid of density 0.5 g cm^{-3} .



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3. The Mechanical Advantage of a hydraulic press is 5.

The ratio of the distance travelled by the load to the effort is _____ .



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4. The length of water column that can exert 1 atm pressure is _____ .



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5. The blotting paper becomes completely wet when one end of the paper is kept in a liquid. This is an example of _____ .



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6. An ice cube's $(1/n)$ th portion sinks in water, then the density of ice is _____ .



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Level 1 Match The Following

Column A		Column B	
A.	Water supply in cities	() a.	Pascal's law
B.	Hydraulic brake	() b.	Archimede's Principle

1.

C.	Sucking of a cool drink by using a straw	() c.	Fluid pressure
D.	Fish weighs less in water than in air	() d.	Laws of floatation
E.	Relative density of solids	() e.	Upthrust
F.	Hydrometer	() f.	Atmospheric pressure
G.	Spherical shape of water drop	() g.	Lactometer
H.	Absorption of water from the ground by roots of plants	() h.	Surface tension
I.	Density of milk	() i.	Viscosity
J.	Mobility of liquids	() j.	Capillarity



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Level 1 Multiple Choice Questions

1. Two pieces of metal when immersed in a liquid have equal upthrust on them, then

A. weights in air

B. densities

C. volumes

D. masses

Answer: C



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2. The pressure at a point inside a fluid is

A. dependent on the height of the fluid column

B. dependent on the density of the fluid

C. equal in all directions

D. All the above are true

Answer: D



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3. When an object is made to float in two different liquids of density d_1 and d_2 , the lengths of the object seen above the liquid surface are l_1 and l_2 , respectively.

Which of the following is the correct alternative ?

A. $d_2 > d_1$, if $l_1 > l_2$

B. $d_1 > d_2$, if $l_2 > l_1$

C. $d_1 < d_2$, if $l_2 > l_1$

D. $d_2 < d_1$, if $l_2 > l_1$

Answer: C



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4. Kerosene lamp glows continuously until the kerosene is exhausted. This is due to the phenomenon of _____ .

A. anomalous expansion

B. capillarity

C. thermal expansion

D. Both (a) and (b)

Answer: B



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5. A liquid whose density is twice the density of mercury is used as a barometric liquid. Then one atmosphere pressure equals _____ cm of the liquid pressure.

A. 76

B. 38

C. 152

D. 380

Answer: B



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6. When two liquids A and B of equal weight are filled inside two identical containers, the height of the liquid Column A is greater than the height of the liquid Column B. If P_A and P_B are the pressures exerted by A and B at the bottom of the containers,

respectively, and d_A , d_B are the densities of A and B, respectively, which of the following statements is true ?

A. $P_A > P_B$

B. $P_A < P_B$

C. $P_A = P_B$

D. $d_A > d_B$

Answer: C



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7. The atmospheric pressure at a given place is dependent on

A. the height of the air column

B. the temperature

C. humidity

D. All the above

Answer: D



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8. A spring balance shows 100 gf reading when a metallic sphere is suspended from its hook. When the completely immersed in water, the reading shown by the balance is 75gf. The relative density of the material of the sphere is

A. 1

B. 2

C. 3

D. 4

Answer: D



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9. An object just floats in water. If common salt is added into the water,

A. the volume of the object immersed in the liquid decreases.

B. the object sinks

C. the object first sinks and then floats up.

D. cannot be determined

Answer: A



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10. A rubber balloon filled with hydrogen gas is left free in air. Then the balloon

A. escapes into space.

B. ascends upto a certain height in air and floats.

C. ascends upto a certain height and then descends back to ground.

D. ascends upto a certain height and explodes

Answer: B



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11. The radius of a press cylinder in a hydraulic press is double the diameter of the pump cylinder. Then

A. mechanical advantage is 16.

B. the work done on the load is equal to
the work done by the effort.

C. mechanical advantage is 4

D. Both (a) and (b)

Answer: D



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12. A substance floats in water, but sinks in coconut oil

The density of the substance

- A. is less than density of water.
- B. is greater than the density of oil.
- C. Both (a) and (b)
- D. Cannot be decided based on the given information

Answer: C





13. The centre of gravity and the centre of buoyancy of a floating body, in stable equilibrium,

(i) are always same.

(ii) are always along a same vertical line.

A. Only (i) is true

B. Only (ii) is true

C. Both (i) and (ii) are true

D. Both (i) and (ii) are false

Answer: D



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14. In the case of the liquids that do not wet the walls of the vessel.

A. cohesive forces are larger than adhesive forces.

B. adhesive forces are large than cohesive forces.

C. Both adhesive and cohesive forces are equal in magnitude.

D. None of the above

Answer: A



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15. When an object of weight W is immersed in a liquid, its weight in the liquid is found to be W_1 . When it is immersed in water, the weight

of the displaced if found to be W_2 . The relative density of the liquid is

A. $\left(\frac{W_2}{W_1}\right)$

B. $\frac{W - W_1}{W_2}$

C. $\frac{W_2}{W - W_1}$

D. $\frac{W_2}{W - W_1}$

Answer: B



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16. The pressure exerted by a liquid column at the bottom of the liquid container is

A. does not depend on the area of cross-section of container.

B. dependent on the density of the liquid.

C. equal in all directions.

D. All the above are true

Answer: D



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17. A manometer is connected to gas container. Then the mercury level rises by 2 cm in the arm of the manometer which is not connected to the container.

If the atmospheric pressure is 76 cm of mercury, then the pressure of the gas is _____ cm of mercury.

A. 80

B. 76

C. 72

D. 78

Answer: A



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18. The radius of the press cylinder in a hydraulic press is equal to the diameter of its pump cylinder. Its mechanical advantage is _____ .

A. 1

B. 2

C. 3

D. 4

Answer: D



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19. Among the following liquids, the pressure inside them at a given depth is the highest in _____ at a constant temperature.

A. fresh water

B. petrol

C. sea water

D. alcohol

Answer: C



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20. Which of the following is used to punch holes in thick metallic block ?

- A. Drilling machine.
- B. Hydraulic press.
- C. Hammer and anvil.
- D. All the above

Answer: B



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21. When a force is applied in the downward direction, for a short duration, on a body

floating with its entire volume in water, the body will then

- A. float with some part of it above the surface of water.
- B. oscillate in vertical direction.
- C. sink to the bottom.
- D. oscillate in horizontal direction.

Answer: C



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22. When equal quantities of an oil, water mercury are poured into a beaker, the order in which the liquids arrange themselves from bottom to top is

A. mercury, water, oil

B. water, mercury, oil

C. water, oil, mercury.

D. mercury, oil water.

Answer: A



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23. In a hydrometer, the floatation bulb is large in size compared to the size of the gravity bulb because

A. it lowers the centre of gravity.

B. it decreases the buoyancy of liquids.

C. it displaces a large amount of liquid, and thus, does not allow the hydrometer to sink completely in the liquid.

D. None of these

Answer: C



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24. A metal block of volume 500 cm^3 and density 2 g cm^{-3} is suspended from a spring balance and one fourth of its volume is immersed in water. The reading on the spring balance is _____ N.

A. 8.575

B. 10.175

C. 500

D. 8.75

Answer: D



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25. A metal box is made up of an alloy of zinc and copper metals. It weighs 302 g and 320 g in liquid of relative density 1.4 and water, respectively. The specific gravities (or relative densities) of copper are 7.4 and 8.9,

respectively. Arrange the following steps in a proper sequential order to find masses of metals in the alloy.

A. Find the weight of the box in a liquid of relative density 1.4 and water along with the relative densities of zinc and copper from the information given in the problem.

B. Note the metals present in the metal box.

C. Let the masses and volumes of copper

and zinc be m_c, m_z, v_c and v_z

respectively. The weight (w) and volume

(v) of the box would be equal to

$m_c + m_z$ and $v_c + v_m$, respectively.

D. The density of the alloy used for the box

is, $d = \frac{(m_c + m_z)}{v_c + v_z}$, substitute

$$v_c = \frac{m_c}{d_c} \text{ and } v_z = \frac{m_z}{d_z} = \frac{(w - m_c)}{d_z},$$

find the masses of m_c and m_z .

Answer: A



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26. Sudden fall of atmospheric pressure by a large amount indicates _____.

- A. arrival of storm
- B. arrival of dust - storm
- C. fair weather
- D. None of the above

Answer: A



27. Two stretched membranes of area 10 cm^2 and 20 cm^2 are held horizontally in a liquid, at the same depth. The ratio of pressures on them is _____ .

A. 1 : 2

B. 2 : 1

C. 1 : 4

D. 1 : 1

Answer: D



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28. In a mercury barometer, if the tube containing mercury is tilted, then

A. height of mercury column remains same.

B. the length of mercury column in the tube increases.

C. the vertical height of the mercury column decreases.

D. Both (a) and (b)

Answer: D



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29. At higher altitudes, the atmospheric pressure is lesser as, at higher altitudes

- A. the length of air column exerting the pressure is less.
- B. density of air decreases.
- C. acceleration due to gravity decreases.
- D. All the above.

Answer: D

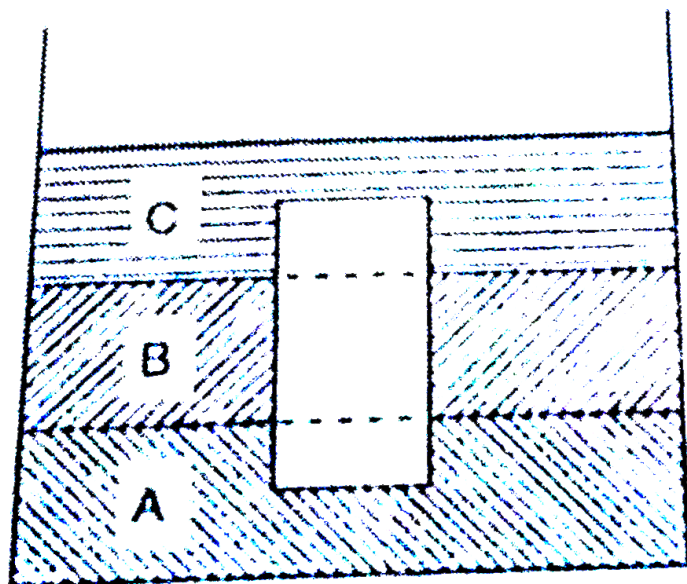


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Level 2

1. An object floats in three immiscible liquids A, B and C of densities 3g cm^{-3} , 2g cm^{-3} , respectively as shown in the figure. When the object is placed in the liquids, the levels of liquid A, B and C rise by 3 cm, 5 cm and 8 cm, respectively. The areas of cross-sections of the container and the object are 10 cm^2 and 5 cm^2 , respectively. Calculate the

density of the object.



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2. A hollow sphere of external and internal diameter 4 cm and 2 cm, respectively, floats in a liquid of density 3.5 g cm^{-3} . The level of the

liquid coincides with the center of the sphere.

Calculate the density of the material of the sphere.

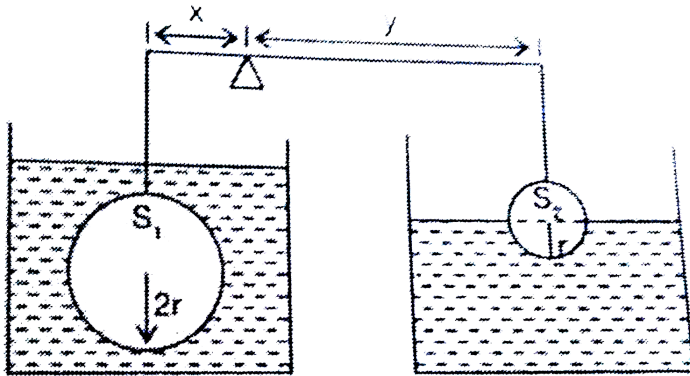


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3. Two sphere S_1 and S_2 made of the same material and having radii $2r$ and r , respectively, are immersed in water and suspended from either end of a beam as shown in figure.

The beam is in equilibrium when $x : y = 1 : 3$

Determine the density of the object.



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4. A simple barometer tube contains some air in it. The length of the tube above the mercury level in the trough is 80 cm. The height of mercury in the tube is 71 cm at normal atmospheric pressure. What is the actual

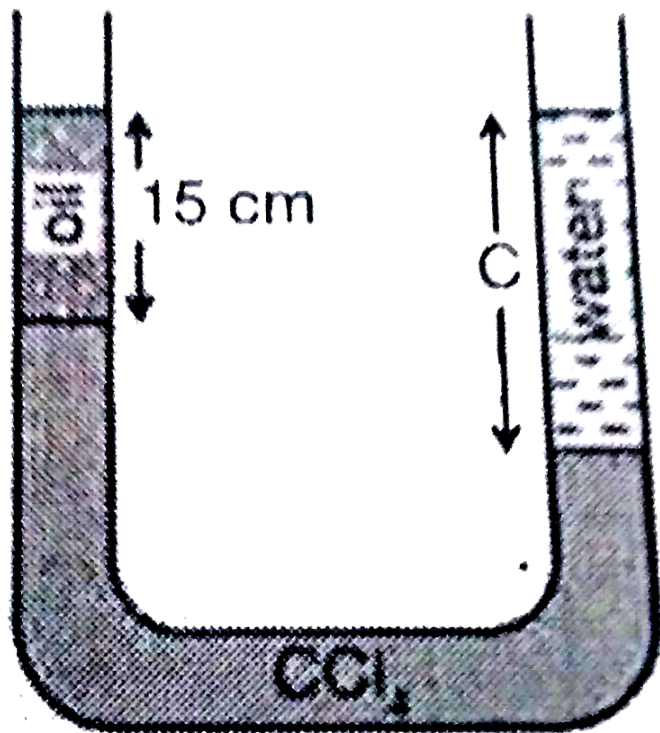
decrease in the atmospheric pressure if the barometer reads 65 cm ?



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5. A 'U' tube contains oil, carbon tetrachloride and water as shown in the figure. The density of oil is 0.8 g cm^{-3} and that of carbon tetrachloride is 1.6 g cm^{-3} . If oil and water surfaces are at the same level, find the height

of the water column.



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6. A metallic sphere is made of an alloy of metals 'P' and 'Q' having specific gravities (or relative densities) 20 and 2, respectively. The sphere weighs 120 gwt in air and 90 gwt in water. Find the percentage of the mass of metal 'P' in the alloy.



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7. A trough contains the two immiscible liquids

'A' and 'B' having densities

' p_A ' and ' p_B ' ($p_B > p_A$). A cylindrical body having uniform area of cross section is immersed completely and vertically in the liquids such that $1/3rd$ of its length is in liquid 'B' and the remaining is in liquid 'A'. Find the density of the body.

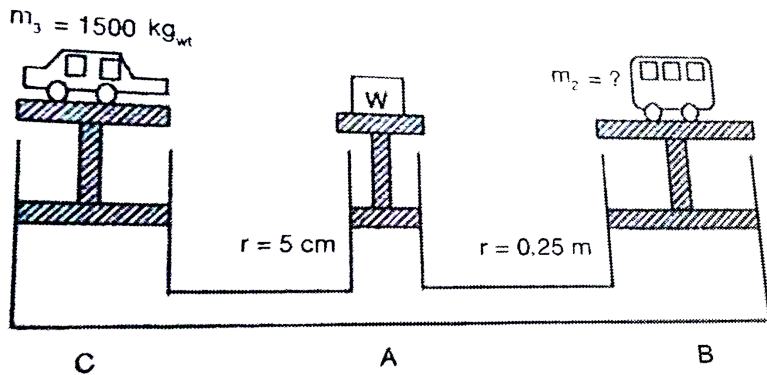


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8. In the figure shown below, cylinder A has pump piston, whereas B and C cylinder have lift pistons. If the maximum weight that can be

placed on the pump piston is 50 kgwt, what is the maximum weight that can be lifted by piston in the cylinder B? Find the total mechanical advantage.

(Take $g = 10 \text{ m s}^{-2}$).



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9. An empty glass test tube floats vertically in water to a depth of 5 cm. Now, on introducing a 8 cm liquid column into the tube, its depth in water is further increased by 4 cm. Now if the empty test tube is allowed to float vertically in the liquid, 5 cm of the tube is seen in air. Find the total length of the tube.



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10. Two metallic spheres 'P' and 'Q' weighing 200 gwt and 150 gwt, respectively, balance each other when immersed in water. If the relative density of 'P' is 2 find the specific gravity of 'Q'.



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11. A gold ornament weighs 570 gram in air and 520 gram in water. If the specific gravity of gold is 19, find the difference in the volume of

water displaced when the ornament is immersed in water and the actual volume of the gold in the ornament. How do you account for this difference in volume ?



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12. A container is filled with two immiscible liquids A and B of densities 2 g cm^{-3} and 3 g cm^{-3} , respectively. A wooden cube of side 1 cm floats on the surface of liquid A such that one-fourth of its total

length is immersed in this liquid (A).

Now, the wooden cube is completely immersed in liquid A by suspending a sinker of volume 10 cm^3 which is completely submerged in liquid B. Determine the weight of the sinker.



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13. A variable immersion hydrometer is used to measure the specific gravity of two liquids. When the hydrometer reads 0.8, half of the total length of the hydrometer stem is

immersed in the liquid and when the hydrometer reads 0.6, $\frac{3}{4}$ th of the total length of the hydrometer stem is immersed in the liquid. What is the maximum and minimum reading that can be measured by using this hydrometer ?



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Level 2 Understanding Based Question

1. An empty cylindrical tank having diameter 5 m is filled with water through a hose pipe having radius 25 cm. If pressure at the bottom of the container increases at a rate of 10^3 Pa s^{-1} , calculate the speed of water flowing through the hose pipe.

(Take $g = 10 \text{ m s}^{-2}$)



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2. Equal volume of a liquid is poured into containers A and B where area of cross-section of container A is double the area of cross-section of container B. If P_A and P_B are pressures exerted at the bottom of the containers, then find $P_A : P_B$.



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3. The left arm of a manometer is connected to a container containing gas 'X' and the mercury

level in the right arm is raised by 2 cm. Now without disconnecting the container of X, the right arm of the manometer is connected to another container containing gas 'Y' and the mercury level in the right arm is pushed down by 5 cm. Find the pressure exerted by the gases 'X' and 'Y'.



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4. An engineer was given a task to measure the rate of increase in pressure at the bottom

of an empty cylindrical tank which is filled with water through hose pipe. If the speed of water coming out of the hose pipe is 10 m s^{-1} , diameter and radius of the cylinder and hose pipe are 5 m and 25 cm, respectively, find the result shown by the engineer. (Take $g = 10 \text{ m s}^{-2}$)



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5. Two hydrogen gas balloons having the same pressure and whose volumes are in the ratio

of 1 : 2, respectively, are released simultaneously into air on the surface of the Earth. Find the ratio of time taken to reach a height of 100 m from the ground. (Neglect the air friction)



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6. A wooden plank immerses upto 50% in water. Then what percentage of its volume is immersed in a liquid of density 0.5 g cm^{-3} ?



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1. n ' different liquids, which do not react chemically, are mixed to form a homogeneous mixture. If the densities of the liquids are $\rho_1, \rho_2, \dots, \rho_n$, respectively, then the density of the homogeneous mixture when

(a) the masses of the liquids forming the mixture are equal

(b) the volumes of the liquids forming the mixture are equal



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2. Why is a lactometer more sensitive than a normal hydrometer ? Explain how the sensitivity of a hydrometer can be increased.



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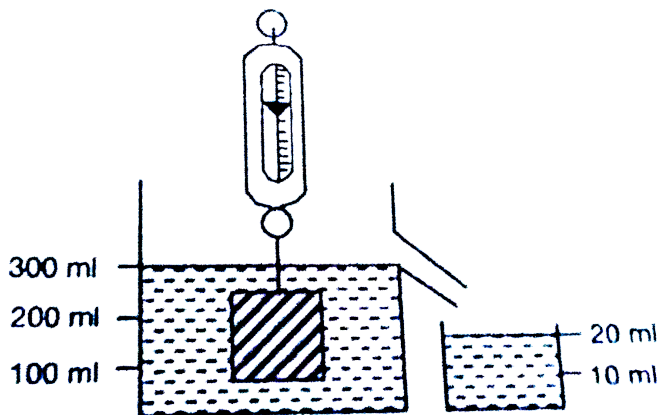
3. An object suspended from a spring balance is immersed in water filled inside an overflow jar. The water displaced by the object is collected in an empty beaker placed below the

spout of the overflow jar.

If the reading on the spring balance is 180 g_{wt} , then calculate the pressure exerted due to the immersion of object at the bottom of the container. Will there be any change in pressure at the lower, if the object is dropped into water ?

The height of the overflow jar upto the spout is 10 cm and the area of the lower face of the

block is 4 cm^2 .



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4. A metallic sphere of density 5 g cm^{-3} is projected upward from the bottom of a pond with a velocity 10 m s^{-1} . The velocity of the sphere on reaching 10 m s^{-1} . The velocity of

the sphere on reaching the surface of the water is found to be 8 m s^{-1} .

Determine the pressure exerted by water at the bottom of the pond. (Neglect the viscous force acting on the sphere).

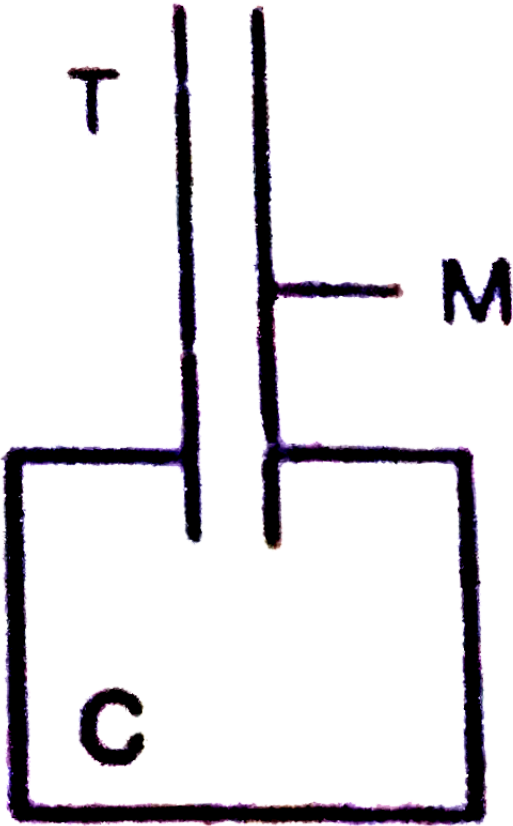


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5. A boy purchases 2 litre of milk from a shop. To find out the extent of adulteration he constructed a device by using a capillary tube (T) and a cylindrical container (C) as shown in

the figure. In order to make the device float upto a mark (M), in pure milk, he adds 10 lead shots each of mass 5 g into it. To make the device float to the same mark in a sample of milk purchased, he removes one lead shot from it. The total weight of the device is 200 gwt. Determine the density of a dultered milk that the shopkeeper adds to the milk. Density of pure milk is 1.045 g cm^{-3} and density of

water is 1 g cm^{-3} .



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Level 3 Understanding Based Question

1. When a cylindrical wooden piece weighing 75 gwt is made to float in water, 25 % of the total volume of the water.

Find the extra force in gwt required to be applied on the piece downwards so that the piece gets immersed in water completely



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2. A uniform cylindrical body when placed in liquid a floats with one third of its length

outside the liquid.

When placed in liquid B, it floats with one third of its length immersed in the liquid.

When the body is made to float vertically in a homogeneous mixture of equal volumes of the two liquids, 25 cm of its length is seen in air.

Find the length of the body.



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3. A small thin cylindrical glass beaker having an area of cross section 6 cm^2 weighs 10 gwt.

If floats vertically in water upto a certain depth with 10 lead shots in it, is 8 cm, how many such lead shots can be added further into it before it sinks.



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4. A spying plane flying over the sea has to make emergency landing due to some technical problem. The operator saw a huge ice block floating in the sea water is $\frac{15}{17}$. If

this plane weighs 360 kgwt and lands on this block, it is found that the ice block.



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5. A hydrometer stem has a length 30 cm. If the hydrometer is immersed in water , its floatation bulb just sinks. If the same hydrometer is immersed in a liquid having density of 500kgm^{-3} , two-third of the stem is immersed. Find the least specific gravity of a

liquid that can be measured using the hydrometer.



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