CHAPTER

01

Fluid Statics

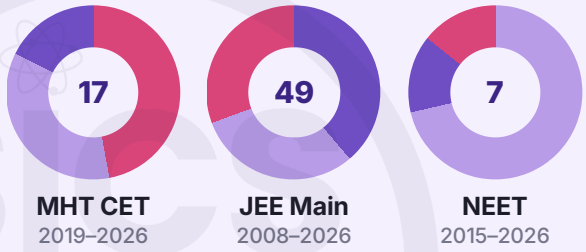
MHT CET · JEE · NEET Physics

PHYSICS CIRCLE

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EXAM WEIGHTAGE



MHT CET 2019–2026 | **JEE Main** 2008–2026 | **NEET** 2015–2026

	CET	JEE	NEET
Pressure in a Fluid	6 (35%)	15 (31%)	5 (71%)
Archimedes' Principle & Floatation	8 (47%)	15 (31%)	1 (14%)
Density, Compressibility & Pascal's Law	3 (18%)	19 (39%)	1 (14%)

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01 CONCEPT Pressure in a Fluid

IN ONE LINE
Pressure at a point in a still fluid depends only on its **depth**, the **liquid** and **g**.

1.1.1 What is pressure?

- Thrust is the normal force of a liquid at rest on a surface.
- Pressure is thrust per unit area.

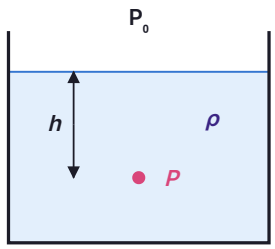
$$P = \frac{F}{A}$$

- SI unit: N/m² or pascal (Pa). CGS unit: dyne/cm².
- Dimensions: $[ML^{-1}T^{-2}]$.
- Pressure at a point acts in **all directions**, with no definite direction. So it is not a vector.
- Other units: atmosphere, bar, torr (mm of Hg).

$$1\ atm = 1.01 \times 10^5\ Pa = 1.01\ bar = 760\ torr$$

- Atmospheric pressure is largest at the earth's surface and falls as we go up.

1.1.2 Pressure at a depth



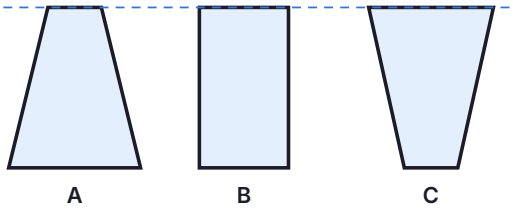
Point at depth h

$$P = P_0 + h\rho g$$

- P_0 is the atmospheric pressure on the free surface.
- **Gauge pressure** is the difference between P and P_0.

$$P - P_0 = h\rho g$$

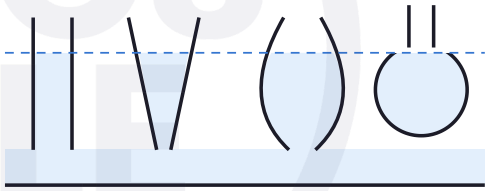
1.1.3 Shape of the vessel does not matter



$P_A = P_B = P_C$, but the weights differ

- P depends on h, ρ and g.
- It is independent of the amount of liquid and the shape or area of the vessel.
- Same height, same liquid: same pressure at the base, though the weight of liquid differs.

1.1.4 Same level, same pressure

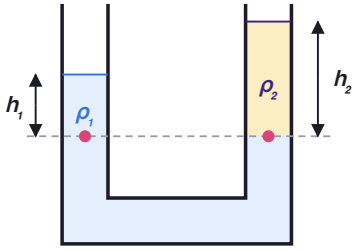


Same level in every limb

Connected vessels of different shapes

- At one horizontal level in a liquid at rest, pressure is the same at all points.
- If it were not, the liquid would flow.
- So connected vessels fill to the same height.

1.1.5 U-tube with two liquids



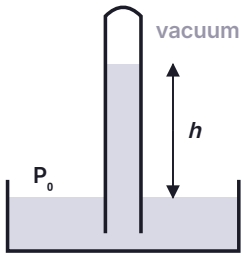
Take the level of the common surface

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- Choose the interface level; both sides have equal pressure there.
- Both open ends are at P_0, so P_0 cancels.

$$h_1\rho_1 = h_2\rho_2$$

1.1.6 Barometer

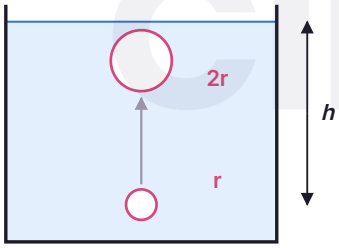


Column balances the atmosphere

$$P_0 = h\rho g$$

- A lighter liquid needs a taller column.
- Mercury: h = 76 cm. A sudden fall in the barometer height warns of a storm.

1.1.7 Air bubble rising in a lake



Radius grows as pressure falls

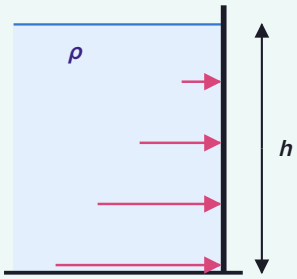
- At constant temperature, PV = constant.
- Write pressures as heights of water: atmosphere = H.

$$(H + d)\, r_1^3 = H\, r_2^3$$

- Radius doubles: volume is 8 times, so d = 7H.

JEE · NEET Corner

Force on a vertical wall



Pressure grows with depth

- Mean pressure on a wall of height h is $\frac{h\rho g}{2}$.
- Force = mean pressure × area of the wall.

$$F = \frac{\rho g h}{2} \times A$$

Levelling of connected vessels

- Water moves from the taller to the shorter column until the levels match.
- Layer of height $\frac{h_1 - h_2}{2}$ crosses over; its centre falls by the same amount.

$$W_{gravity} = \frac{1}{4}\rho g A(h_1 - h_2)^2$$

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Solved Examples 01 Pressure in a Fluid

SOLVED 1 NEET 2026

A submarine is designed to withstand an absolute pressure of 100 atm. How deep can it go below the water surface? (density of water = 1000 kg m^{-3}, 1 atm = 1×10^5 Pa, g = 10 m/s^2)

(a) 990 m (b) 9900 m
(c) 99 m (d) 9000 m

STEP 1 $P = P_0 + \rho gh \Rightarrow \rho gh = 100\text{ atm} - 1\text{ atm} = 99 \times 10^5$ Pa
STEP 2 $h = \dfrac{99 \times 10^5}{1000 \times 10}$
STEP 3 $h = \mathbf{990\ m}$

Answer: **(a)**

SOLVED 2 MHT CET 2026 · 18 Apr · Shift 1

The pressure at half the depth of a lake is equal to two-third the pressure at the bottom of the lake. The depth h of the lake is (ρ = density of water, g = acceleration due to gravity, P_0 = atmospheric pressure)

(a) $\dfrac{2P_0}{\rho g}$ (b) $\dfrac{P_0}{\rho g}$
(c) $\dfrac{2P_0}{3\rho g}$ (d) $\dfrac{P_0}{2\rho g}$

STEP 1 $P_0 + \dfrac{\rho gh}{2} = \dfrac{2}{3}(P_0 + \rho gh)$
STEP 2 $\dfrac{P_0}{3} = \dfrac{2\rho gh}{3} - \dfrac{\rho gh}{2} = \dfrac{\rho gh}{6}$
STEP 3 $h = \mathbf{\dfrac{2P_0}{\rho g}}$

Answer: **(a)**

SOLVED 3 NEET 2022 · Phase 2

Two copper vessels A and B have the same base area but of different shapes. A takes twice the volume of water as that of B to fill upto a particular common height. Then the correct statement is

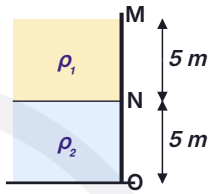
(a) Vessel B weighs twice that of A
(b) Pressure on the base area of vessels A and B is same
(c) Pressure on the base area of vessels A and B is not same
(d) Both vessels A and B weigh the same

STEP 1 Pressure at the base: P = hρg
STEP 2 Same h and same liquid; the shape of the vessel does not enter
STEP 3 **Pressure on the two bases is the same**

Answer: **(b)**

SOLVED 4 JEE Main 2020 · 8 Jan · Shift 2

Two liquids of densities ρ_1 and ρ_2 ($\rho_2 = 2\rho_1$) are filled behind a square wall of side 10 m. Each liquid has a height of 5 m. The ratio of the forces due to these liquids on the upper part MN to that on the lower part NO is (the liquids do not mix)



(a) $\dfrac{1}{3}$ (b) $\dfrac{1}{2}$
(c) $\dfrac{1}{4}$ (d) $\dfrac{2}{3}$

STEP 1 Upper part: mean $P = \dfrac{\rho_1 g(5)}{2} = 2.5\rho_1 g$
STEP 2 Lower part: mean $P = 5\rho_1 g + \dfrac{\rho_2 g(5)}{2} = 5\rho_1 g + 5\rho_1 g = 10\rho_1 g$
STEP 3 Equal areas ⇒ ratio = $\dfrac{2.5}{10} = \mathbf{\dfrac{1}{4}}$

Answer: **(c)**

SOLVED 5 NEET 2020 · Phase 2

A barometer is constructed using a liquid (density = 760 kg/m^3). What would be the height of the liquid column, when a mercury barometer reads 76 cm? (density of mercury = 13600 kg/m^3)

(a) 0.76 m (b) 1.36 m
(c) 13.6 m (d) 136 m

STEP 1 Same atmospheric pressure: $h_1\rho_1 = h_2\rho_2$
STEP 2 $h \times 760 = 0.76 \times 13600$
STEP 3 $h = \mathbf{13.6\ m}$

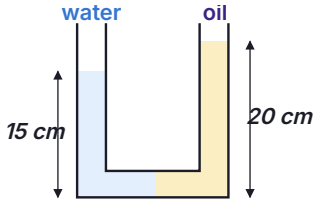
Answer: **(c)**

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Solved Examples 01 Pressure in a Fluid (contd.)

SOLVED 6 NEET 2019

In a U-tube water and oil are in the left and right side of the tube respectively. The heights from the bottom for water and oil columns are 15 cm and 20 cm respectively. The density of the oil is (ρ_{water} = 1000 kg/m³)



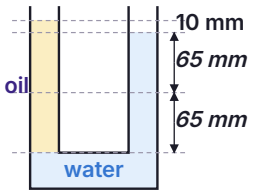
(a) 1333 kg/m³ (b) 1200 kg/m³
(c) 750 kg/m³ (d) 1000 kg/m³

STEP 1 Pressure is equal at the bottom level: $h_1\rho_1 = h_2\rho_2$
STEP 2 $15 \times 1000 = 20 \times \rho$
STEP 3 ρ = **750 kg/m³**

Answer: **(c)**

SOLVED 7 NEET 2017

A U tube with both ends open to the atmosphere is partially filled with water. Oil, immiscible with water, is poured into one side until it stands 10 mm above the water level on the other side. Meanwhile the water rises by 65 mm from its original level. The density of the oil is



(a) 425 kg m^{-3} (b) 800 kg m^{-3}
(c) 928 kg m^{-3} (d) 650 kg m^{-3}

STEP 1 Water level difference = 65 + 65 = 130 mm; oil column = 130 + 10 = 140 mm
STEP 2 $\rho \times 140 = 1000 \times 130$
STEP 3 $\rho = \frac{13000}{14} \approx$ **928 kg m^{-3}**

Answer: **(c)**

SOLVED 8 MHT CET 2026 · 13 May · Shift 2

When a large bubble rises from the bottom of a water lake to its surface, its radius doubles. If the atmospheric pressure equals the pressure of height H of a water column, the depth of the lake is

(a) 2H (b) H
(c) 7H (d) 4H

STEP 1 Constant temperature: PV = constant
STEP 2 $(H + d)r^3 = H(2r)^3$ (pressures in metres of water)
STEP 3 $H + d = 8H \Rightarrow d =$ **7H**

Answer: **(c)**

SOLVED 9 MHT CET 2025 · 20 Apr · Shift 2

The temperature of an air bubble rising from bottom to surface of a lake remains constant but its diameter is doubled. If the pressure on the surface is h metre of mercury column and the relative density of mercury is ρ, the depth of the lake is

(a) 5hρ (b) 7hρ
(c) $\frac{3h}{\rho}$ (d) $\frac{4h}{\rho}$

STEP 1 Volume becomes 8 times, so bottom pressure = 8 × surface pressure
STEP 2 Extra pressure = 7h metre of mercury
STEP 3 Height of water = 7h × ρ = **7hρ**

Answer: **(b)**

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02 CONCEPT Density, Compressibility & Pascal's Law

IN ONE LINE

Density tells how much mass sits in a volume. Pascal's law says pressure on an enclosed fluid spreads **equally**.

1.2.1 Density

$$\rho = \lim_{\Delta V \to 0} \frac{\Delta m}{\Delta V} = \frac{dm}{dV}$$

- It is a scalar with dimensions $[ML^{-3}]$.
- SI unit kg/m³; 1 $\frac{g}{cc}$ = 10^3 kg/m³.
- Immiscible liquids settle with the densest at the bottom, with plane interfaces.

1.2.2 Relative density

$$RD = \frac{\text{Density of body}}{\text{Density of water}}$$

- Also called specific gravity. If it is x, density = x g/cm³ = x × 10^3 kg/m³.

1.2.3 Mixture of two liquids

Mixed	Density of mixture	If equal
masses m_1, m_2	total mass ÷ total volume	$\frac{2\rho_1\rho_2}{\rho_1 + \rho_2}$ (harmonic mean)
volumes V_1, V_2	$\frac{\rho_1 V_1 + \rho_2 V_2}{V_1 + V_2}$	$\frac{\rho_1 + \rho_2}{2}$ (arithmetic mean)

1.2.4 Effect of temperature and pressure

- Heating expands the volume, so density falls: $\rho \approx \rho_0(1 - \gamma\Delta\theta)$.
- Raising pressure reduces volume, so density rises. Compressibility is $\frac{1}{B}$.

$$B = \frac{\Delta P}{\Delta V \div V} \Rightarrow \frac{\Delta V}{V} = \frac{\Delta P}{B}$$

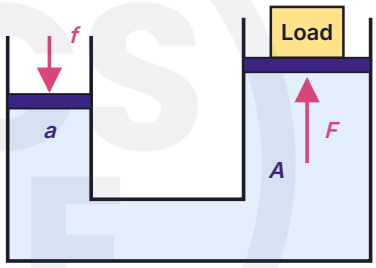
$$\rho \approx \rho_0\left(1 + \frac{\Delta P}{B}\right)$$

- At depth h in a liquid, $\Delta P = h\rho g$.
- Smaller B means the liquid compresses more.

1.2.5 Pascal's law

- An increase in pressure at one point of an enclosed liquid is transmitted **equally** to all points and to the walls.
- Uses: hydraulic lift, hydraulic press, hydraulic brakes.

1.2.6 Hydraulic lift



Small force on a small piston lifts a heavy load

$$\frac{f}{a} = \frac{F}{A} \Rightarrow F = f\left(\frac{A}{a}\right)$$

- Since A ≫ a, F ≫ f.
- Circular pistons: $\frac{A}{a} = \frac{D^2}{d^2}$.
- Force is multiplied, work is not.

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FLUID STATICS

PRESSURE · PASCAL · ARCHIMEDES · FLOATATION

LEVEL 1 · EASY

Topic-wise Previous Year Questions

MHT CET · NEET · JEE Main

22	6	3
questions	concepts	topics

CONTENTS

01	Pressure in a Fluid	Q 1–4	4 Qs
02	Density, Compressibility & Pascal's Law	Q 5–17	13 Qs
03	Archimedes' Principle & Floatation	Q 18–22	5 Qs
	Answer key		

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TOPIC 01

Pressure in a Fluid

4 PYQs · Easy 4 · Medium 0 · Difficult 0 | MHT CET 0 · NEET 2 · JEE 2

Concepts covered: Pressure at a depth (3) · U-tube, barometer & connected vessels (1)

LEVEL 1 · EASY 4 questions

◆ Pressure at a depth 3 Qs

1. A submarine is designed to withstand an absolute pressure of 100 atm. How deep can it go below the water surface?
(Consider the density of water $= 1000\,\text{kg m}^{-3}$, $1\,\text{atm} = 1 \times 10^5\,\text{Pa}$ and gravitational acceleration $g = 10\,\text{m/s}^2$)

NEET 2026

(a) 990 m (b) 9900 m (c) 99 m (d) 9000 m

2. Given below are two statements:

Statement I: Pressure of a fluid is exerted only on a solid surface in contact as the fluid-pressure does not exist everywhere in a still fluid.

Statement II: Excess potential energy of the molecules on the surface of a liquid, when compared to interior, results in surface tension.

In the light of the above statements, choose the correct answer from the options given below

JEE MAIN 2026 · 22 JAN · SHIFT 1

(a) Statement I is false but Statement II is true
(b) Statement I is true but Statement II is false
(c) Both Statement I and Statement II are false
(d) Both Statement I and Statement II are true

3. Given below are two statements:

Statement I: Pressure in a reservoir of water is same at all points at the same level of water. Statement II: The pressure applied to enclosed water is transmitted in all directions equally. In the light of the above statements, choose the correct answer from the options given below:

JEE MAIN 2023 · 10 APR · SHIFT 1

(a) Both Statement I and Statement II are false
(b) Statement I is false but Statement II is true
(c) Statement I is true but Statement II is false
(d) Both Statement I and Statement II are true

◆ U-tube, barometer & connected vessels 1 Q

4. A barometer is constructed using a liquid (density = $760\,\text{kg/m}^3$). What would be the height of the liquid column, when a mercury barometer reads 76 cm?
(density of mercury = $13600\,\text{kg/m}^3$)

NEET 2020 · PHASE 2

(a) 0.76 m (b) 1.36 m (c) 13.6 m (d) 136 m

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TOPIC 02

Density, Compressibility & Pascal's Law

13 PYQs · Easy 13 · Medium 0 · Difficult 0 | MHT CET 3 · NEET 0 · JEE 10

Concepts covered: Density, mixtures & compressibility (5) · Pascal's law & hydraulic lift (8)

LEVEL 1 · EASY 13 questions

◆ Density, mixtures & compressibility 5 Qs

5. The bulk modulus of a liquid is 3×1010 Nm^{-}2. The pressure required to reduce the volume of liquid by 2% is:

JEE MAIN 2022 · 24 JUN · SHIFT 1

(a) 3×108 Nm^{-}2 (b) 9×108 Nm^{-}2
(c) 6×108 Nm^{-}2 (d) 12×108 Nm^{-}2

6. The Bulk moduli of Ethanol, Mercury and water are given as 0.9, 25 and 2.2 respectively in units of 109 Nm^{-}2. For a given value of pressure, the fractional compression in volume is $\frac{}{V}^{\Delta V}$. Which of the following statements about $\frac{\Delta V}{V}$ for these three liquids is correct?

JEE MAIN 2014 · 11 APR · SHIFT 1

(a) Ethanol > Water > Mercury
(b) Water > Ethanol > Mercury
(c) Mercury > Ethanol > Water
(d) Ethanol > Mercury > Water

7. A sample of a liquid is kept at 1 atm. It is compressed to 5 atm which leads to a change of volume of 0.8 cm3. If the bulk modulus of the liquid is 2 GPa, the initial volume of the liquid was _____ litre. (Take 1 atm = 105 Pa)

JEE MAIN 2025 · 8 APR · SHIFT 2 *(Numerical)*

8. The increase in pressure required to decrease the volume of a water sample by 0.2% is P $\times 10^{5}$Nm^{-2}. Bulk modulus of water is 2.15×10^{9}Nm^{-2}. The value of P is _____.

JEE MAIN 2025 · 24 JAN · SHIFT 2 *(Numerical)*

9. A certain pressure 'P' is applied to 1 litre of water and 2 litre of a liquid separately. Water gets compressed to 0.01% whereas the liquid gets compressed to 0.03%. The ratio of Bulk modulus of water to that of the liquid is $\frac{3}{x}$. The value of x is _____.

JEE MAIN 2023 · 1 FEB · SHIFT 1 *(Numerical)*

◆ Pascal's law & hydraulic lift 8 Qs

10. In a hydraulic press, the piston in the small cylinder has a diameter of d_1 cm, while the larger piston has a diameter of d_2 cm. If a force F_1 is applied to the small piston, then the force F_2 on the large piston is given by

MHT CET 2026 · 19 MAY · SHIFT 2

(a) $F_2 = \frac{d_2^2}{d_1^2} F_1$ (b) $F_2 = \frac{d_1^2}{d_2^2} F_1$
(c) $F_2 = \frac{d_2^2}{d_1^2} \frac{1}{F_1}$ (d) $F_2 = \frac{d_1^2}{d_2^2} \frac{1}{F_1}$

11. In a hydraulic press, the small cylinder has a diameter of d_1 cm, while the large cylinder has a diameter of d_2 cm. If a force F_1 is applied to a piston of small cylinder, then the force on the piston of large cylinder F_2 is

MHT CET 2026 · 12 MAY · SHIFT 1

(a) $\frac{d_1^2}{d_2^2} \frac{1}{F_1}$ (b) $\frac{d_1^2}{d_2^2} F_1$ (c) $\frac{d_2^2}{d_1^2} \frac{1}{F_1}$ (d) $\frac{d_2^2}{d_1^2} F_1$

12. A piston of cross-sectional area 2.5×10^{-2} m^2 is used in a hydraulic lift to exert a force of 250 N on water. The cross-sectional area of the other piston which supports a car of mass 3000 kg is ($g = 9.8$ m/s^2)

MHT CET 2026 · 18 APR · SHIFT 1

(a) 1.96 m^2 (b) 2.94 m^2 (c) 3.92 m^2 (d) 5.88 m^2

13. A hydraulic automobile lift is designed to lift vehicles of mass 5000 kg. The area of cross section of the cylinder carrying the load is 250 cm^2. The maximum pressure the smaller piston would have to bear is [Assume $g = 10$ m/s^2]

JEE MAIN 2023 · 8 APR · SHIFT 2

(a) $20 \times 10^{+6}$ Pa (b) $200 \times 10^{+6}$ Pa
(c) $2 \times 10^{+5}$ Pa (d) $2 \times 10^{+6}$ Pa

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14. Given below are two statements: one is labelled as Assertion **A** and the other is labelled as Reason **R**

Assertion A: When you squeeze one end of a tube to get toothpaste out from the other end, Pascal's principle is observed.

Reason R: A change in the pressure applied to an enclosed incompressible fluid is transmitted undiminished to every portion of the fluid and to the walls of its container.

In the light of the above statements, choose the most appropriate answer from the options given below

JEE MAIN 2023 · 6 APR · SHIFT 2

(a) Both A and R are correct but R is NOT the correct explanation of A

(b) A is not correct but R is correct

(c) A is correct but R is not correct

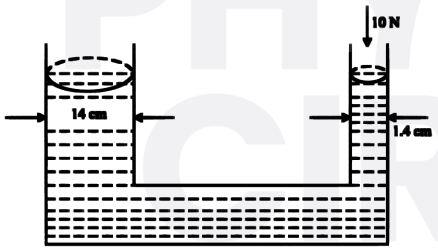
(d) Both A and B are correct and R is the correct explanation of A

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15. In a hydraulic lift, the surface area of the input piston is 6 cm2 and that of the output piston is 1500 cm2. If 100 N force is applied to the input piston to raise the output piston by 20 cm, then the work done is _____ kJ.

JEE MAIN 2025 · 29 JAN · SHIFT 1 *(Numerical)*

16.



A hydraulic press containing water has two arms with diameters as mentioned in the figure. A force of 10 N is applied on the surface of water in the thinner arm. The force required to be applied on the surface of water in the thicker arm to maintain equilibrium of water is _____ N.

JEE MAIN 2024 · 5 APR · SHIFT 2 *(Numerical)*

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17. A hydraulic press can lift 100 kg when a mass 'm' is placed on the smaller piston. It can lift _____ kg when the diameter of the larger piston is increased by 4 times and that of the smaller piston is decreased by 4 times keeping the same mass 'm' on the smaller piston.

JEE MAIN 2021 · 24 FEB · SHIFT 1 *(Numerical)*

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TOPIC 03

Archimedes' Principle & Floatation

5 PYQs · Easy 5 · Medium 0 · Difficult 0 | MHT CET 2 · NEET 0 · JEE 3

Concepts covered: Archimedes' principle & upthrust (1) · Floatation (4)

LEVEL 1 · EASY 5 questions

◆ Archimedes' principle & upthrust 1 Q

18. Consider a solid sphere of radius R and mass density $\rho(r) = \rho_0\left(1 - \frac{r^2}{R^2}\right), 0 < r \leq R$

The minimum density of a liquid in which it will float is:

JEE MAIN 2020 · 8 JAN · SHIFT 1

(a) $\frac{2\rho_0}{3}$ (b) $\frac{2\rho_0}{5}$ (c) $\frac{\rho_0}{5}$ (d) $\frac{\rho_0}{3}$

◆ Floatation 4 Qs

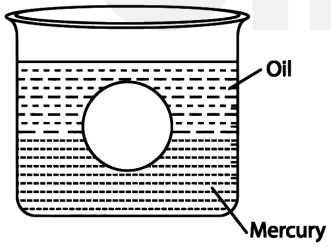
19. A vessel contains oil (density $= 0.6$ g/cm ^{3}) over mercury (density $= 13.6$ g/cm ^{3}). A homogeneous sphere floats with half its volume immersed in mercury and the remaining half in oil. The density of the material of the sphere in g/cm^3 is

MHT CET 2026 · 12 MAY · SHIFT 1

(a) 6.8 (b) 6.3 (c) 7.1 (d) 7.2

20. A vessel contains oil (density $= 0.8$ gm/cm^3) over mercury (density $= 13.6$ gm/cm^3). A homogeneous sphere floats with half of its volume immersed in mercury and the other half in oil. The density of the material of the sphere in gm/cm^3 is

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(a) 12.8 (b) 7.2 (c) 6.4 (d) 3.3

21. A cubical block of density $\rho_b = 600$ kg/m^3 floats in a liquid of density $\rho_e = 900$kg/m^3. If the height of block is $H = 8.0$ cm then height of the submerged part is

____ cm.

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(a) 6.3 (b) 4.3 (c) 7.3 (d) 5.3

22. A 400 g solid cube having an edge of length 10 cm floats in water. How much volume of the cube is outside the water?

(Given: density of water = 1000 kg m-3)

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(a) 400 cm3 (b) 600 cm3 (c) 1400 cm3 (d) 4000 cm3

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ANSWER KEY

Shaded by level: **Easy**

01 Pressure in a Fluid

1. (a)	2. (a)	3. (d)	4. (c)						

02 Density, Compressibility & Pascal's Law

5. (c)	6. (a)	7. 4	8. 43	9. 1	10. (a)	11. (d)	12. (b)	13. (d)	14. (d)
15. 5	16. 1000	17. 25600							

03 Archimedes' Principle & Floatation

18. (b)	19. (c)	20. (b)	21. (d)	22. (b)					

Note: *"Bonus" = no option is correct as the question is printed (dropped in the official key). Numerical questions show the numerical answer.*

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