Newton's 3rd Law

Key Concepts

- **Force** — An external influence that changes or tries to change an object's motion or direction.
- **Unit of Force** — Newton (N), measured using a spring scale.
- **Newton (unit definition)** — The force that gives a mass of 1 kg an acceleration of 1 m/s^2.
- **Newton's Third Law** — For every action, there is an equal and opposite reaction ($F_1 = -F_2$).

Comparison / Relationship Tables

Newton's Three Laws of Motion

Law	Statement	Key Concept	Formula
Third Law	Every action has an equal and opposite reaction	Interaction between two bodies	$F_1 = -F_2$

Action–Reaction Force Pairs

Action	Reaction
Balloon expels air downward	Air pushes balloon upward
Person pushes wall	Wall pushes person backward
Rifle fires a bullet	Rifle recoils backward
Hand pushes table	Table pushes hand upward
Earth's gravity pulling birds downward	Birds pulling earth upward

Nature of Action and Reaction Forces

Property	Action & Reaction
Magnitude	Equal
Direction	Opposite
Type	Same nature (e.g., gravitational)
Object	Acts on two different bodies
Resultant	Never zero (different bodies)

Q & A Section

❓ What does the third law confirm about forces in the universe?

💬 There is no single force; action and reaction forces always occur in pairs.

❓ Why can't action and reaction forces cancel each other?

💬 Because they act on different objects.

Common Mistakes & Exam Traps

⚠️ Forgetting that action and reaction act on **different bodies**.

⚠️ Believing action and reaction cancel each other.

Hydrodynamics

Key Concepts

- **Fluid** — Any substance that flows and has no fixed shape; includes liquids and gases.
- **Density (ρ)** — Mass per unit volume; unit: kg/m³.
- **Relative Density** — Ratio of a material's density to the density of water at 4°C; has no unit.

Relative density of a material = Mass of a volume of the material / Mass of the same volume of water 4°C

- **Laminar Flow** — Liquid layers slide smoothly without intersecting streamlines.
- **Streamlines** — Imaginary paths that each small portion of liquid follows in laminar flow
  - they never intersect and their tangent shows the instantaneous velocity direction.
- **Streamline Density** — The number of streamlines passing perpendicularly through a unit area at a point - it indicates the flow speed, higher when speed increases and lower when speed decreases.
- **Turbulent Flow** — Violent flow with vortices formed when speed exceeds a limit.
- **Steady Flow** — Velocity at each point stays constant over time.
- **Viscosity** — Resistance between liquid layers that prevents easy sliding.
- **Viscosity Coefficient (η)** — Tangential force on unit area causing unit velocity difference between two layers separated by unit distance
  - Viscosity coefficient of a pure liquid depends on its **type** and **temperature**
  - Its unit is N.s/m² or kg/(m.s).
- **Continuity Equation** — $A_1v_1 = A_2v_2$ for steady incompressible flow.

Comparison / Relationship Tables

Factors affecting densities

Factor	Result
Difference in the atomic or molecular mass of the substance	Heavier atoms or molecules → higher density
Difference in inter-atomic or intermolecular spaces between atoms or molecules	More separated atoms or molecules → less density

Effects of Density on Floating

Item	Condition	Result	Example
Object Density < Liquid Density	Lower density	Object floats	Ice on water
Object Density > Liquid Density	Higher density	Object sinks	Metals in water

Applications of Density Measurement

Application	Density measured	Observation / Result	Meaning
Car Battery	Electrolytic solution	Density decreases → discharging Increases → recharging	Lower density → discharged. Higher density → charged
Blood	Healthy density of blood (1040–1060 kg/m³)	Increase = high blood cell conc. Decrease = low concentration	High density → more cells. Low density → possible anemia
Urine	Healthy density of urine (~1020 kg/m³)	Density increases when salt concentration increases	Higher density may indicate certain diseases

Laminar vs Turbulent Flow

Feature	Laminar Flow	Turbulent Flow	Observation
Motion	Smooth layers	Vortices	Vortices appear at high speeds
Streamlines	Do not intersect	Break and swirl	Smoke example
Speed Condition	Low–moderate	High	Speed limit triggers turbulence

Steady Flow Conditions

Condition	Description	Related Effect
Tube Filled	Fluid occupies whole tube	Ensures continuity
Equal Inflow = Outflow	Same amount per time	incompressible fluid → Constant flow rate
Velocity Constant	At each point	No change per time

Continuity Equation: Area vs Velocity

Point	Area	Velocity	Relationship
Wide section	Large A	Low v	$v \propto 1/A \rightarrow v \propto 1/r^2 \rightarrow v \propto 1/d^2$
Narrow section	Small A	High v	$A_1v_1 = A_2v_2 \rightarrow r_1^2v_1 = r_2^2v_2 \rightarrow d_1^2v_1 = d_2^2v_2$

Viscosity: Low vs High

Property	Low Viscosity	High Viscosity	Example
Flowability	Flows easily	Flows slowly	Water vs honey
Resistance	Low	High	Alcohol vs glycerin
Ball Drop Time	Short	Long	Water vs glycerin

Forces in Viscosity Setup (Two Plates)

Layer	Velocity	Cause	Result
Layer near fixed plate	Zero	Adhesion	Stationary
Layer near moving plate	v	Adhesion	Moves with plate
Middle layers	Between 0 and v	Internal friction	Gradual velocity change

Applications of Viscosity

Application	Substance Behavior	Result
Lubricating Engines	High viscosity oils	Reduce wear and heat during machine operation
Vehicle Motion	Air resistance	- Moderate fuel use at low or mid speed ($F_{friction}$ α Velocity) - High fuel use at high speed ($F_{friction}$ α Velocity^2)
Blood Test	High precipitation rate	If red blood cells stick together → precipitation rate increases above normal → rheumatic fever
	Low precipitation rate	if red blood cells break down → precipitation rate decreases below normal → anemia

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💬 Q & A Section

❓ Why are gold alloy densities different?

💬 Mixing gold with other metals changes composition and lowers density.

❓ Why does blood slow in capillaries?

💬 Total cross-sectional area increases greatly, reducing velocity. (A_1v_1 = **n** A_2v_2)

❓ What does slow blood speed in capillaries allow?

💬 Exchange of oxygen, carbon dioxide, and nutrients with tissues.

❓ What makes gases different from liquids as fluids?

💬 Gases are easily compressible and fill any space, while liquids resist compression and have a definite volume.

❓ **Why are liquids considered incompressible in laminar flow?**

💬 Because liquids resist compression almost entirely, so their volume and density remain constant.

❓ **What causes gases to become turbulent?**

💬 When a gas diffuses from a small space to a larger one or moves from high to low pressure, forming vortices.

❓ **What law is the continuity equation based on?**

💬 The Law of Conservation of Mass.

❓ **Why can't water be used as a lubricant?**

💬 Its low viscosity makes it flow away quickly and it cannot adhere to machine parts during motion.

❓ **Which forces act on a ball falling in a liquid?**

💬 Weight downward, buoyant force upward, and viscous friction against the direction of motion (upward).

🚫 Common Mistakes & Exam Traps

⚠️ Thinking relative density has units — it is a ratio with no unit.

⚠️ Assuming viscosity depends on Force or velocity or area or depth — it depends on type and temperature only.

⚠️ Mixing mass flow rate and volume flow rate — both stay constant but are different quantities.

Hydrostatics

Key Concepts

- **Pressure** — Average force acting perpendicularly on unit area.
- **Liquid Pressure at Depth** — Pressure at a depth *h* in a liquid equals *ρgh*.
- **Total Pressure in a Liquid** — Sum of atmospheric pressure and liquid pressure: $P_{total} = Pa + \rho gh$.
- **Pressure Direction in Liquids** — Acts in all directions. But force on any surface is perpendicular to it.
- **Atmospheric Pressure** — Pressure exerted by the wight of air column on any surface.

Comparison / Relationship Tables

Pressure and Depth Relationship

Item	Fact	Observation	Result
Depth (h)	Greater depth → greater pressure	Seen in submerged objects	Pressure α h
Density (ρ)	Higher density → higher pressure	Same depth, different liquids	Pressure α ρ
Horizontal Level	Same level → same pressure	Applies inside any liquid	Equal pressures

Design Applications of Pressure

Item	Reason	Result
Dam base	Pressure increases with depth	Base made thicker
Diving suit	High pressure at great depths	Suit inflated with air
Sinus equalization	Pressure difference near surface	Blow air to equalize

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💬 Q & A Section

❓ Why do divers need helmets at great depths?

💬 To protect the head from very high external pressure underwater.

❓ What unit is used to measure pressure?

💬 Pressure is measured in Newton per square meter (N/m^2).

❓ Why can a pointed human heel exert more pressure than an elephant's foot?

💬 Because pressure increases when the contact area becomes very small, even if the force is smaller.

❓ Why does a submerged cork rise when released?

💬 Because pressure at the lower part of the cork is greater than at its upper part, producing an upward force.

❓ How do divers equalize pressure at shallow depths?

💬 By blowing air into their sinuses to balance external pressure.

❓ Why is the diving suit inflated with air at great depths?

💬 To resist the very high external water pressure and protect the diver.

🚫 Common Mistakes & Exam Traps

⚠️ Pressure don't only act downward — pressure acts in **all directions**, but force is **perpendicular** to surfaces.

⚠️ Liquids at different shapes don't have different levels — in connecting vessels they rise to **one level**.

⚠️ Don't forget atmospheric pressure in total pressure — total pressure includes **Pa + ρgh**.

⚠️ Pressing force (F = P . A) depends on the liquid column height and area.

Newton 3rd Law

1. According to Newton's Third Law, the action and reaction forces:

a) act on the same body

b) are equal in magnitude and have the same direction

c) act on two different bodies and are equal in magnitude but opposite in direction

d) act on the same body and have the same magnitude and same direction

2. In the opposite figure, a hockey player hits the ball with his stick. The action and reaction forces do not cancel each other because:

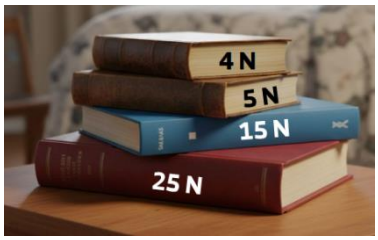
a) the force of the stick on the ball is greater than the force of the ball on the stick

b) the two forces act on different bodies

c) the force of the stick on the ball is less than the force of the ball on the stick

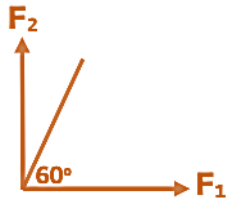
d) the two forces act on the same body

3. Four books are placed on a table. Their weights are 4 N, 5 N, 15 N, and 25 N. The reaction force of the table on all the books together equals:



a) 25 N b) 49 N c) 5 N d) 15 N

4. According to Newton's Third Law, the correct graphical relationship between the magnitude of the action force (F_1) and the reaction force (F_2), when both are drawn using the same scale, is:



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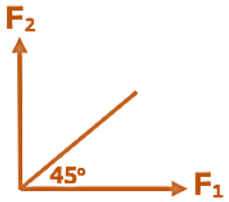
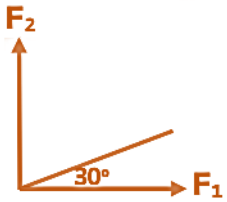
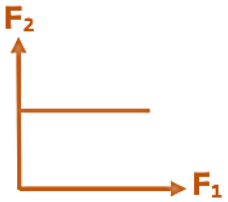


(C)



(B)



(A)

5. The motion of birds during flight is one of the most common examples of which law?

a) Newton's First Law

b) The Law of Inertia

c) Newton's Second Law

d) Newton's Third Law

6. The mathematical form of Newton's Third Law can be written in all of the following ways except:

a) $m_1\Delta v_1/\Delta t = m_2\Delta v_2/\Delta t$

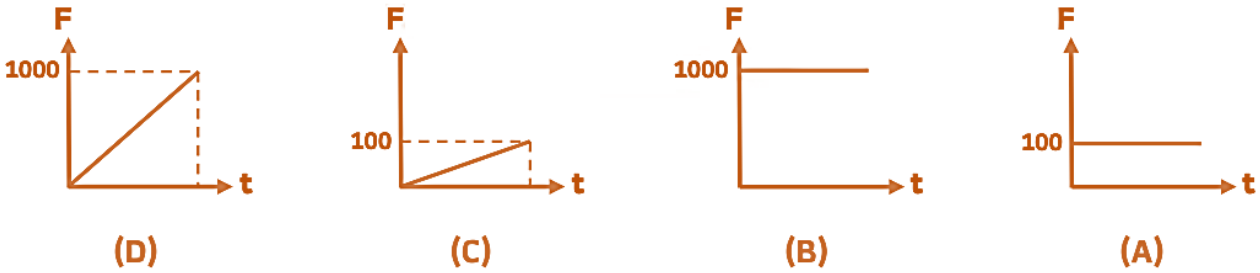
b) $m_1a_1 = m_2a_2$

c) $F_1\Delta v_1/\Delta t = F_2\Delta v_2/\Delta t$

d) $F_1 = -F_2$

7. A person of mass 70 kg pushes an elephant of mass 7000 kg.

If the person exerts a constant force of 100 N on the elephant, then the elephant exerts on the person a reaction force (F) that can be represented graphically by the relation:



8. A cannon does not recoil with the same speed as the projectile moves forward because:

a) the cannon is fixed in position

b) action and reaction forces are opposite in direction

c) the inertial masses of the cannon and the projectile are different

d) action and reaction are unbalanced forces

9. The force that causes the cart to move forward is:

a) the force exerted by the man on the cart

b) the force exerted by the cart on the man

c) the force exerted by the ground on the cart

d) the force exerted by the ground on the man

10. The opposite figure shows a collision between two bodies X and Y, each of mass 4 m arranged as shown.

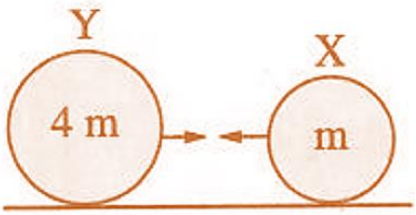
If body X exerts a force F on body Y during the collision, then body Y exerts on body X a force of

a) $\frac{1}{4}F$

b) $-F$

c) F

d) $4F$



11. A man is rowing a boat in a river:

(1) Identify the action and reaction forces.

(2) Explain why the two forces are not balanced.

(3) If the oars push the water with 50 N, calculate the acceleration of the boat if its total mass is 250 kg.

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12. A man is pushing an elephant while both stand on movable platforms.

(1) What is the relationship between the force on the elephant and the force on the man?

(2) Why are the two forces not balanced?

(3) If the mass of the elephant is 100 times the mass of the man, compare the accelerations of their motions.

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13. A rocket is launched upward:

(1) Identify the action and reaction forces in this situation.

(2) Explain why the two forces are not balanced.

(3) If the downward thrust of the escaping hot gases is 8×10^6 N, calculate the upward thrust (force) acting on the rocket if its mass is 6×10^6 kg

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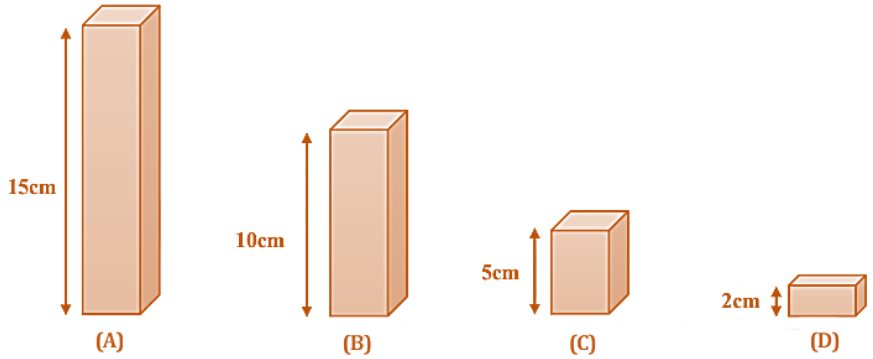
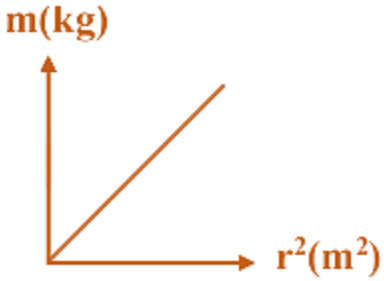
Density

14. The graph shows four blocks, each made of glass with a density of 2.6 g/cm³. The base area of each block is 1 cm². Which shape has a mass of 13 g?



15. The graph shows the relationship between the mass (m) and the square of the base radius (r) for a number of solid copper cylinders all of which have the same height (h). The density of copper = …..



a) slope of the graph

b) (slope of the graph)/(π h)

c) (π h)/(slope of the graph)

d) (slope graph)/(π² h)

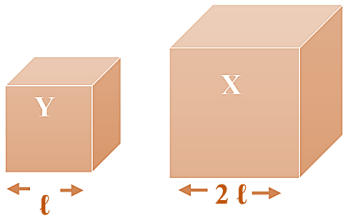
16. In the figure, there are two cubes of different materials with the same mass. The relationship between the density of each of them is .....

a) $\rho_y = 2\ \rho_x$

b) $\rho_y = 4\ \rho_x$

c) $\rho_y = 0.5\ \rho_x$

d) $\rho_y = 8\ \rho_x$



17. Two balls (A, B) The mass of ball a) is three times the mass of ball b), and its radius is equal to the diameter of ball b). Then the ratio of the density of ball a) to the density of ball b) (ρ_a / ρ_β) is equal to:

a) 3/8 b) 5/3 c) 2/3 d) 8/3

18. When measuring the density of equal volumes of different blood samples, if the density of blood for a healthy person is 1060 kg/m³ and the volume of the blood sample is 2.076×10^{-5} m³, then the blood sample for a person with anemia is ....

a) (1)

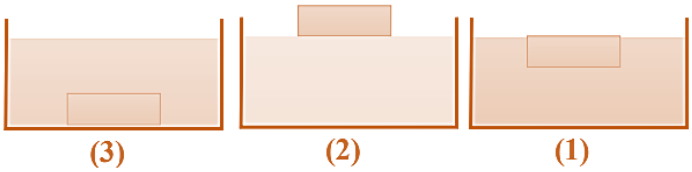
b) (2)

c) (3)

d) (4)

Sample	1	2	3	4
Mass (gm)	21	22	23	24

19. Three identical copper cubes were placed inside three different liquids as shown in the figure. When calculating the density of each liquid, we get .....



a) $\rho(1) > \rho(2) > \rho(3)$

b) $\rho(3) > \rho(2) > \rho(1)$

c) $\rho(1) > \rho(3) > \rho(2)$

d) $\rho(2) > \rho(1) > \rho(3)$

20. An empty container has a mass of 10 kg. When it was completely filled with water, its mass became 17 kg. Then it was emptied and filled with another liquid, so the mass of the container with the liquid became 20 kg. The relative density of the liquid is …….

a) 1.34

b) 1.71

c) 1.22

d) 1.43

21. In the laboratory for testing the concentration of salts in urine, the results for four people were as follows. Which of the above people has increased salts in the urine?

a) Person d)

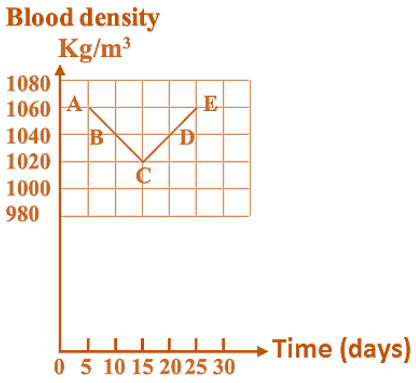
b) Person b)

c) Person a)

d) Person c)

Person	A	B	C	D
$(Kg/m^3)\rho_{urine}$	1020	1030	1010	1019

22. The graph shows the variation in blood density of a person under normal observation over a period of 30 days. Which periods indicate that the person is suffering from anemia?



a) AB, DE

b) CD, BC

c) AB, CD

d) BC, DE

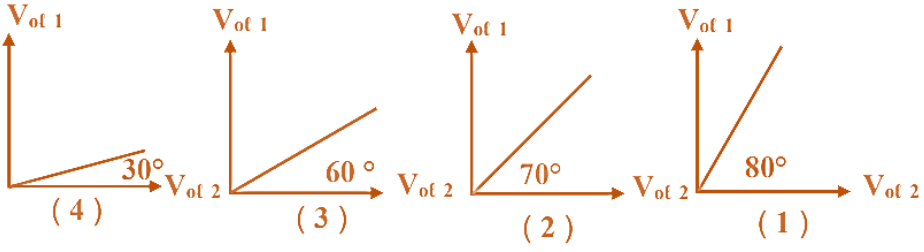
23. You have four graphs that represent the relationship between the volumes of equal masses of different substances (V_{ot1}) and the volumes of the same masses of water (V_{ot2}). The substance with the highest relative density is …….

a) 1

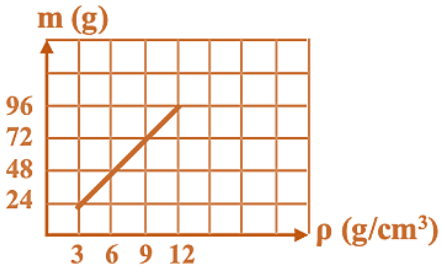
b) 2

c) 3

d) 4



24. The opposite graph represents the relationship between mass and density for a number of different materials when the volume is constant. Which of the following graphs represents the volume of one of these materials?

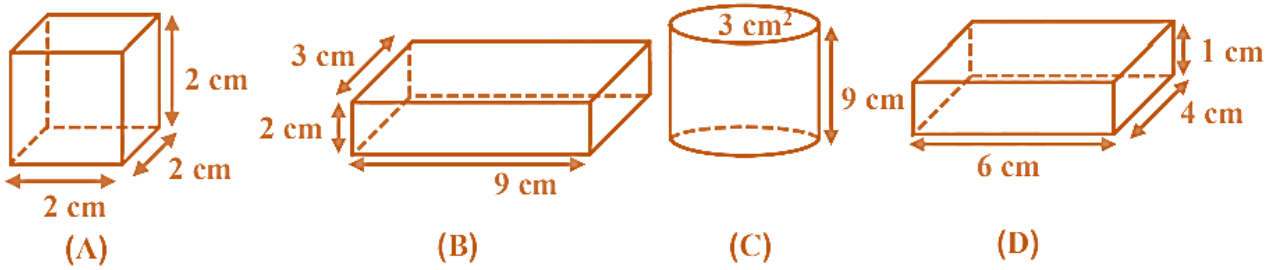


a) A

b) B

c) C

d) D



25. Two equal volumes of iron and aluminum have a difference in mass of 12.75 kg.
If the ratio of their densities (iron : aluminum) is 26/9, the mass of each metal is:

a) Iron = 19.5 kg and Aluminum = 6.75 kg

b) Iron = 20.8 kg and Aluminum = 8.05 kg

c) Iron = 26.0 kg and Aluminum = 13.25 kg

d) Iron = 17.0 kg and Aluminum = 4.25 kg

26. A barrel can hold 90 kg of water or 60 kg of gasoline. If the density of water is 1000 kg/m³, then the density and relative density of gasoline are:

a) 667 – 0.667 kg/m³

b) 0.667 – 667 kg/m³

c) 0.9 – 900 kg/m³

d) 0.6 – 600 kg/m³

27. Two metallic spheres, the first has a radius (r) and density (ρ) and the second has a radius (2r) and density (2ρ). The ratio between their masses equals ……

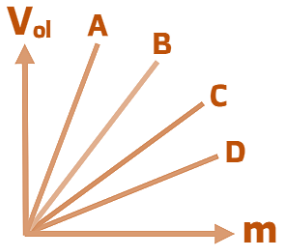
a) 1/4

b) 1/2

c) 1/8

d) 1/16

28. The following graph shows the relationship between volume and mass for several solid pieces made of different materials. The correct relationship expressing the densities of the materials is:



a) $\rho_A > \rho_B > \rho_C > \rho_D$

b) $\rho_D > \rho_C > \rho_B > \rho_A$

c) $\rho_A = \rho_B = \rho_C = \rho_D$

d) $\rho_A = \rho_B > \rho_C = \rho_D$

29. The ratio of the density of the electrolyte solution in a car battery after the battery is discharged to its density after the battery is recharged is:

a) Greater than one

b) Less than one

c) Equal to one

d) May be greater or less than one

30. A solution is formed by mixing 50 cm^3 of water of density 1000 kg/m^3 with 40 cm^3 of another liquid of density 820 kg/m^3.

If the total volume of the solution equals the sum of the two volumes before mixing, then the density of the solution is:

a) 1800 kg/m^3

b) 1128 kg/m^3

c) 920 kg/m^3

d) 846 kg/m^3

31. The ratio of the density of the electrolytic solution in a car battery after discharging the electric charge from the battery to its density after recharging the battery is:

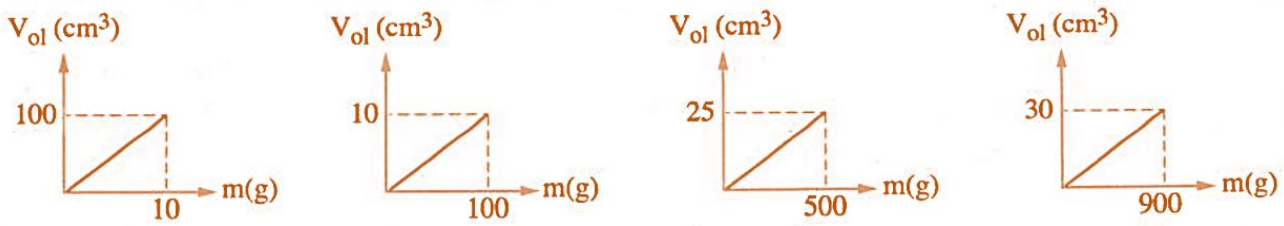
a) greater than 1

b) equal to 1

c) less than 1

d) cannot be determined

32. Which of the following graphs represents the relationship between the mass and volume of solid pieces of a metal whose density is 10^4 kg/m³?



33. Two metals X and Y have densities ρ_x and $2\rho_x$ respectively. We want to mix two volumes of them to form an alloy. Which of the following ratio pairs represents the best ratio of mixing the two volumes to obtain an alloy of greatest possible density, assuming the total volume does not change upon alloy formation?

	Ratio of metal X volume	Ratio of metal Y volume
a)	1	1
b)	2	1
c)	3	2
d)	2	3

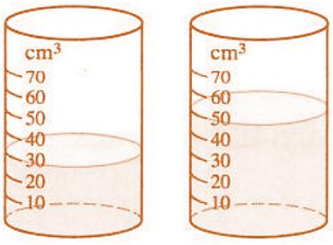
a) 1 : 1

b) 1 : 2

c) 2 : 3

d) 3 : 2

34. The opposite figure represents two glass cups each containing a different quantity of water of density 1000 kg/m³. If these two quantities are added together at the same temperature, the density of the water becomes:



a) 500 kg/m³

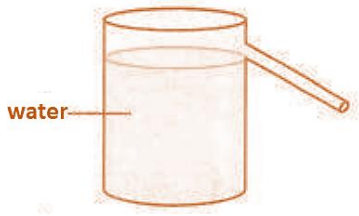
b) 1000 kg/m³

c) 800 kg/m³

d) 2000 kg/m³

35. The figure represents a displacement cup filled with water of density 1000 kg/m³.

When a solid object of density 2700 kg/m³ and mass 1.35 g is immersed in the water, the volume of water displaced is:



a) 0.5 cm^3

b) 0.5 m^3

c) 1.35 cm^3

d) 1.35 m^3

36. Two solid bodies a and b have the same mass and are made of two materials whose densities are 3000 kg/m³ and 4000 kg/m³ respectively. The ratio between the volumes of the two bodies (V_{ol} a / V_{ol} b) equals:

a) 1/3

b) 4/3

c) 3/4

d) 1/4

37. In the opposite figure: container (1) contains a volume V_{o1} of a liquid Y whose relative density is 0.8, and container (2) contains a volume $2V_{o1}$ of water. Find $\frac{m_{water}}{m_{Liquid}}$:

a) 2/1

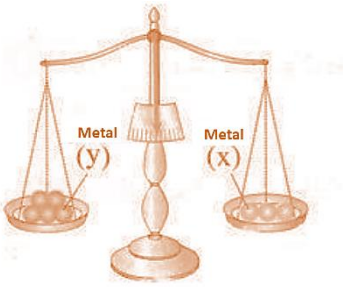
b) 8/5

c) 5/2

d) 10/1

38. In the opposite figure, the masses of two groups of balls are equal. One group is made of metal x and the other group is made of metal y.

If all balls are solid and have the same volume, and their numbers are as shown in the figure, then the ratio between the densities of the two metals (ρ_x / ρ_y) is:



a) 1 / 1

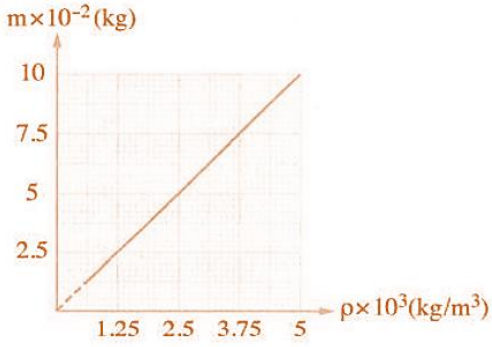
b) 5 / 3

c) 3 / 5

d) 8 / 3

39. The opposite graph represents the relationship between mass (m) and density (ρ) for pieces of equal volume (V_{ol}) made of different materials.

For each material, the value of volume (V_{ol}) is:



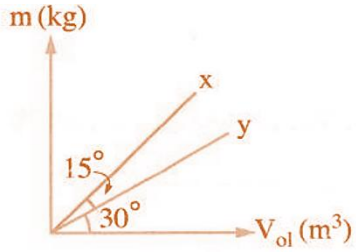
a) 10 cm^3

b) 30 cm^3

c) 40 cm^3

d) 20 cm^3

40. The opposite graph represents the relationship between mass (m) and volume (V_{ol}) for two materials x and y. For each of them, the ratio between their densities (ρ_x / ρ_y) equals:



a) 0.46

b) 2.15

c) 1 / √3

d) √3

41. A graduated cylinder contains 40 cm^3 of glycerin of density 1.26 g/cm^3. A quantity of water of density 1 g/cm^3 is added to it. If the density of the mixture becomes 1.1 g/cm^3 and assuming that mixing does not cause any change in total volume, then the volume of added water equals:

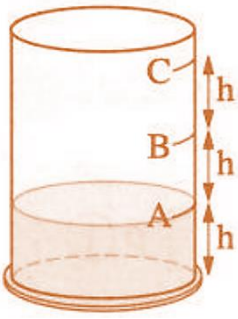
a) 40 cm^3

b) 44 cm^3

c) 52 cm^3

d) 64 cm^3

42. The opposite figure shows a container of mass m containing a quantity of liquid X whose relative density is 2. If a quantity of liquid Y of mass m is added to the container without mixing with X, and the free surface of liquid Y rises to level C, then the relative density of liquid Y equals:



a) 1

b) 2

c) 3

d) 4

43. Two solid spheres made of two different materials: the first has radius r and density ρ, and the second has radius 2r and density 2ρ. The ratio between their masses (m_1 / m_2) is:

a) 1 / 2

b) 1 / 4

c) 1 / 8

d) 1 / 16

44. A liquid of density ρ and volume V_o is mixed with another liquid of density 2ρ and volume $2V_o$. If the total volume of the mixture equals the sum of the volumes of the two liquids before mixing, calculate the density of the mixture in terms of ρ.

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45. A cube of iron has a side length of 12 cm and a mass of 7 kg. Given that the density of iron = 7800 kg/m³, determine whether this cube is solid or contains cavities (air gaps). Explain your answer.

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46. Calculate the density and relative density of aluminum if a volume of 0.1 m³ has a mass of 270 kg.

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47. A cylindrical aluminum container with a thick wall has a mass of 5 kg when empty. Its height is 30 cm and its inner radius is 20 cm. Calculate the mass of the oil that completely fills the container. Given that: Density of aluminum = 2700 kg/m³ - Density of oil = 800 kg/m³

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Continuity & Viscosity

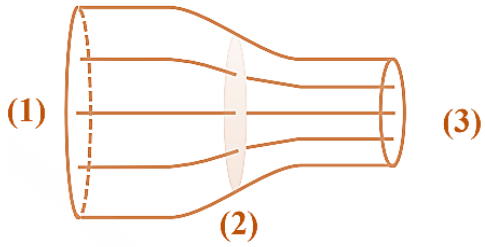
47. The figure shows a flow tube through which the liquid flows in a laminar (streamline) flow. Then:

a) The mass flow rate at (1) has the greatest value

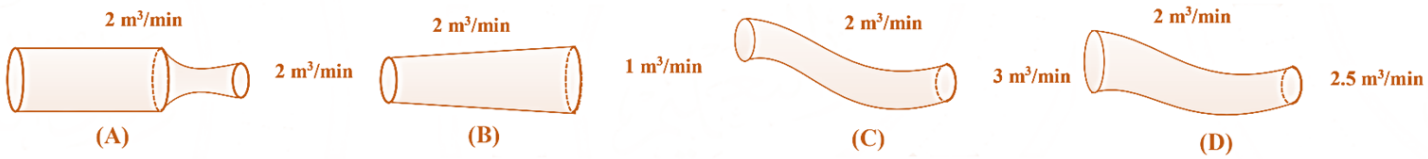
b) The mass flow rate at (2) has the greatest value

c) The mass flow rate at (3) has the greatest value

d) The mass flow rates are equal at all points



48. From the figures given, determine which one represents steady flow?



49. In steady flow of liquids, the ratio between the number of streamlines passing through the wide section of the tube to the number of streamlines passing through the narrow section of the same tube equals .....

a) Greater than one

b) Equal to one

c) Less than one

d) Equal zero

50. In the adjacent figure representing a tube with water flowing in steady flow:

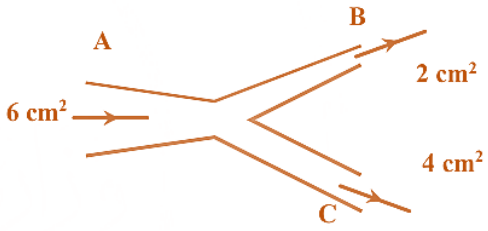
If the velocity of water at **A** and **C** is **8 m/s** and **4 m/s** respectively, then its velocity at **B** is:

a) 6 m/s

b) 8 m/s

c) 12 m/s

d) 16 m/s



51. A liquid flows through a tube of uniform diameter (X) with velocity (v).

If a cork stopper is placed at the end of the tube, and the diameter of the hole in the cork is equal to X/4, then the velocity of the liquid emerging through the hole in the cork equals ……

a) 16 v

b) 4 v

c) 1/4 v

d) 1/16 v

52. Can water be used for lubricating metallic machines?

a) Yes, because it is a low-cost liquid and it cools the machine parts.

b) No, because its viscosity is low and it causes corrosion of metals.

c) Yes, because it adheres to the machine parts, fully covering and protecting them from corrosion.

d) No, because liquid water cannot be used for cooling metals.

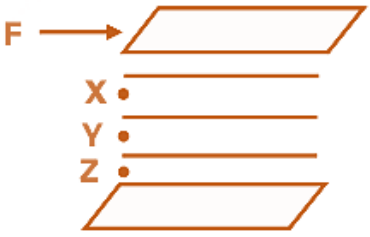
53. A liquid is confined between two parallel plates. A tangential force is applied to the upper plate to move it, so the velocity of the points shown in the figure will be as follows:

a) $V_z < V_y < V_x$

b) $V_z = V_y = V_x$

c) $V_z < V_y = V_x$

d) $V_z > V_y > V_x$



54. Four identical metallic balls are fallen down from the same height, each ball toward a separate jar where each jar contains a different liquid from the other jars.

The time taken by each ball to reach the bottom of the jar is recorded:

Jar 1	Jar 2	Jar 3	Jar 4
0.2 s	0.3 s	0.6 s	1 s

Which jar contains the liquid with higher viscosity?

a) Jar 1 b) Jar 2 c) Jar 3 d) Jar 4

55. Two plates, a and b, move on the surface of a liquid with the same velocity.

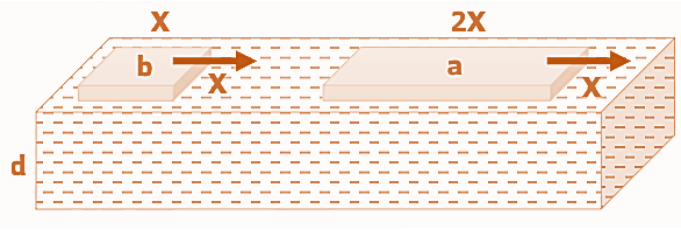
The ratio between the forces Fa/Fb is equal to the ratio:

a) 2/1

b) 1/1

c) 4/1

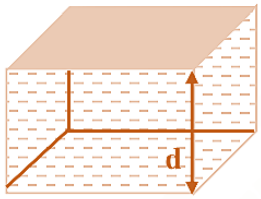
d) 1/2



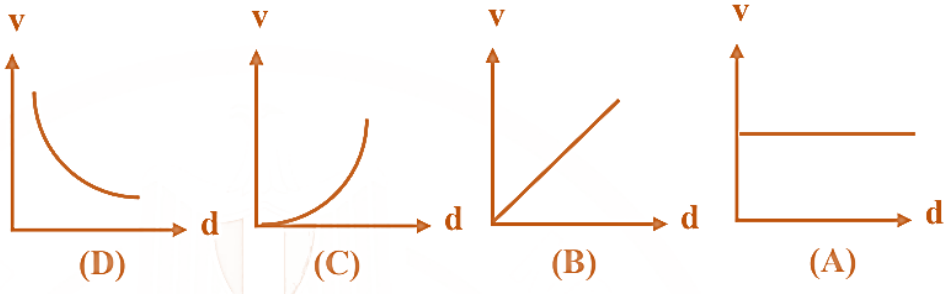
The upper plate (moving)

56. The figure represents a sample of a liquid confined between two plates: the lower plate (stationary) and the upper plate (moving).

Which of the following graphs represents the relationship between the velocity of flow of each liquid layer (v) and the depth of that layer d)?



The lower plate (stationary)



57. A tube of diameter 10 cm ends with a diameter 2.5 cm. If the velocity of water in the wide section of the tube is 1 m/s. Given that the density of water is 1000 kg/m³

a) 4 m/s - 118 kg

b) 8 m/s - 235 kg

c) 16 m/s - 472 kg

d) 25 m/s - 785 kg

58. In a steady flow, if the radius of a tube is doubled, the mass flow rate ……

a) Doubles

b) decreases to a quarter

c) remains constant

d) decreases to half

59. If the cross-sectional area of a tube in which a liquid flows steady increases to double, the volume flow rate ……

a) Doubles

b) decreases to a quarter

c) remains constant

d) decreases to half

60. When measuring the speed of a liquid in a pipe, the value of the speed at a certain point at that moment was 8 m/s, and at another moment at the same point the speed became 9 m/s, then the type of flow is …..

a) Turbulent flow

b) Steady flow

c) Steady then turbulent flow

d) Turbulent then steady flow

61. The ratio between the sedimentation rate of red blood cells in anemia patients and in rheumatic fever patients is ……..

a) Less than one

b) Equal one

c) Greater than one

d) less or greater than one

62. Water flows steadily through a pipe of radius 4 cm with a speed of 2 m/s. The volume of the liquid that flows in one minute is …… m^3

a) 0.151

b) 0.302

c) 0.452

d) 0.603

63. If you know that the volume flow rate of a liquid is 2×10^{2} m^3/s and the mass flow rate is 2×10^{5} kg/s, then its density is …… kg/m^3

a) 500

b) 750

c) 1000

d) 1500

64. A certain mass flow rate of two different liquids passes through two flow tubes. The ratio of their densities is 1/4, and the volume of the first liquid is twice that of the second. If the mass flow rate is constant, then the ratio t_1/t_2 ……

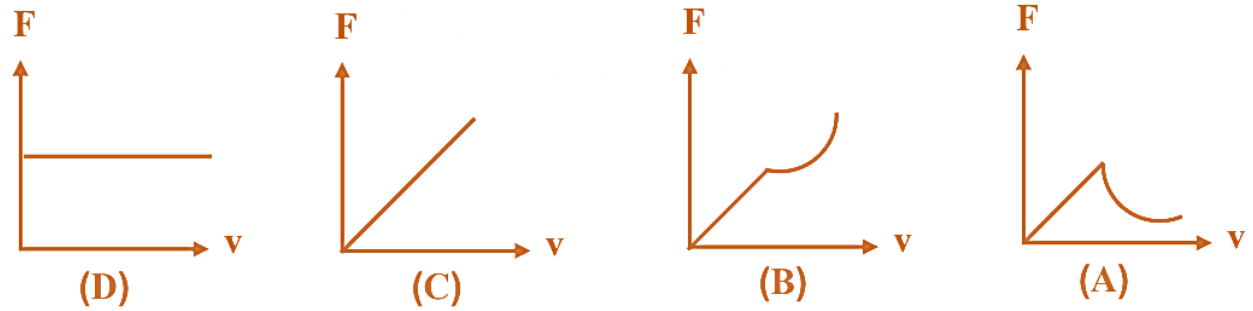
a) 1/2

b) 2/1

c) 1/4

d) 4/1

65. A car starts from rest and its speed increases until it exceeds 120 km/h. Which of the following graphs correctly represents the relationship between speed and air resistance?



66. A liquid flows through a tube with a speed v. If its speed increases to 2v, the ratio r_2/r_1 is ……

a) 1/2

b) √2 / 1

c) 2 / 1

d) 1 / √2

67. If a tank of volume V_{ol} and two taps x and y. When tap x alone is used, the tank fills in 15 min. When tap y alone is used, the tank fills in 30 min. The required time to fill the tank when using taps x and y together equals:

a) 5 min

b) 10 min

c) 15 min

d) 45 min

68. Blood flows with an average speed of 0.33 m/s in one artery of an adult person.
If the radius of this artery is 0.7 cm, and the blood divides into 30 branch arteries whose radius is 0.35 cm each, then the average speed of blood flow in the branch arteries equals:

a) 0.011 m/s

b) 0.022 m/s

c) 0.033 m/s

d) 0.044 m/s

69. The number of flow lines passing perpendicularly through a given area at a point determines the ……

a) speed of the fluid at that point

b) volumetric flow rate

c) mass flow rate

d) fluid density

70. A tube of diameter 2.5 cm is used to pour 11 kg of water in 10 s. Find the speed of water exiting the tube. (Given: $\rho_{water} = 1000\ kg/m^3$, $\pi = 22/7$)

a) 2 m/s

b) 2.24 m/s

c) 3 m/s

d) 3.32 m/s

71. A pump discharges 1.2 m^3 of oil in 60 s into a cylindrical tank of diameter 4 m and height 3 m. If the density of oil is 820 kg/m^3, then:

(I) The mass flow rate of oil from the pump outlet equals ……

a) 0.02 kg/s

b) 5.2 kg/s

c) 16.4 kg/s

d) 18.4 kg/s

(II) The time required to fill the tank with oil equals ……

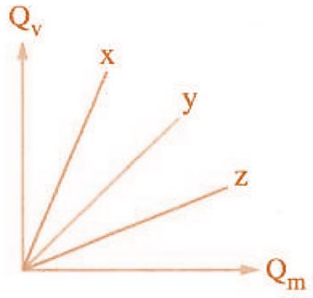
a) 27.21 min

b) 31.43 min

c) 42.43 min

d) 51.54 min

72. The opposite graph represents the relationship between volumetric flow rate (Q_v) and mass flow rate (Q_m) for three fluids x, y, and z flowing steadily in different pipes. Thus:



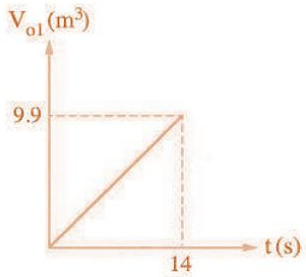
a) $\rho_z < \rho_x < \rho_y$

b) $\rho_z < \rho_y < \rho_x$

c) $\rho_z < \rho_y < \rho_z$

d) $\rho_z < \rho_x < \rho_z$

73. A fluid flows steadily inside a tube of uniform cross section. The opposite graph represents the relationship between the volume of fluid (V_{ol}) passing a certain cross section and the time of flow (t). If the speed of the fluid is 0.9 m/s, then the radius of the tube equals:



a) 0.3 m

b) 0.5 m

c) 0.9 m

d) 1.2 m

74. A tube of radius r branches into several branch tubes whose radius is 0.04 r each. If the speed of fluid flow in any branch tube is five times the speed of flow in the main tube, then the number of subsidiary tubes equals:

a) 5

b) 125

c) 140

d) 150

75. A viscous fluid flows steadily inside a cylindrical tube. If the speed of the fluid along the axis of the tube is V, then the speed of the fluid layer touching the tube walls equals:

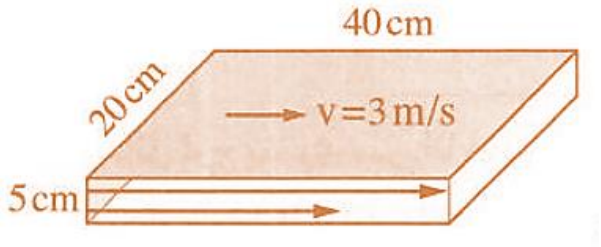
a) 2 V

b) V

c) V / 2

d) zero

76. A tangential force of 10 N is applied to the upper plate to move it with a uniform speed of 3 m/s over a liquid layer of thickness 5 cm, whose area is 40 cm × 20 cm, as shown in the figure. The coefficient of viscosity of the liquid equals:



a) 0.021 N·s/m²

b) 0.48 N·s/m²

c) 0.75 N·s/m²

d) 2.08 N·s/m²

77. A liquid layer of thickness x lies between two plates. The viscosity coefficient of the liquid is 0.2 kg/m·s. One plate is stationary while the other plate (area = 2 cm²) moves with uniform speed, producing a displacement of 100×10^{0} m in 4 s. The force needed to move the plate equals:

a) 10 N

b) 10^{-3} N

c) 10^{-4} N

d) 0.1 N

78. When a swimmer jumps into water, reaches a certain depth below the water surface, then rises again to the surface, the force that changes it direction is:

a) the weight of the swimmer

b) the friction force of the water on the swimmer

c) the water buoyant force on the swimmer

d) all of these forces

79. Three taps are used to fill a tank. The first fills the tank in 1 hour, the second fills the tank in 1/2 hour, and the third fills the tank in 1/4 hour.

Calculate the time required to fill the tank if all three taps are opened at the same moment.

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80. A main artery of an adult person has a cross-sectional area of 3 cm^2 and a blood flow velocity of 30 cm/s. The blood is distributed into a number of capillaries, each having a cross-sectional area of 3×10^{-5} m^2 and a velocity of 0.05 cm/s. Calculate the number of capillaries.

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81. A circular plate of diameter 140 cm slides with a speed of 0.1 m/s on a layer of viscous liquid of thickness 2.5 mm and coefficient of viscosity 2.5 kg/(m·s). Calculate the tangential force acting on the plate. (Given that $\pi = 22/7$)

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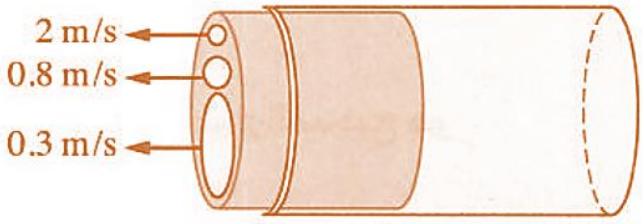
82. A tube of radius 5 cm ends with a cap containing three holes whose radii are 0.5 cm, 1 cm, and 2.5 cm.If the speeds of water through the three holes are 0.3 m/s, 0.8 m/s, and 2 m/s respectively, then calculate:

(1) The speed of water flow in the main tube.

(2) The volume of water flowing in the main tube during half a minute.



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Pressure

83. If you know that the unit of force is the newton and it is equal to kg. m/s². Which of the following units is used to measure pressure?

a) kg . m^{-2} . s^{-1}

b) kg . m^{-2} . s^{-2}

c) kg . m^{-1} . s^{-2}

d) kg . m^{-1} s^{-1}

84. A tangential force of 200 N affected the upper surface of a cube with a side length of 10 cm. The resulting pressure is equal to .....

a) 2×10^4 N/m²

b) 2×10^5 N/m²

c) 2×10^3 N/m²

d) Zero

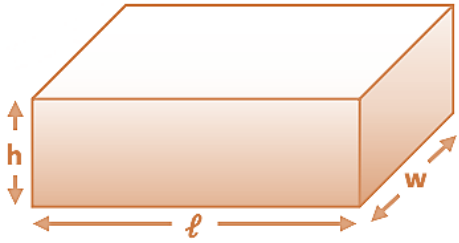
85. A cuboid with dimensions (ℓ, w, h) is placed on a horizontal surface as shown in the figure. The maximum pressure exerted on the surface can be calculated from the relationship

a) Pmax = Fg/(w.h)

b) Pmax = ρ.w.g

c) Pmax = Fg/(Lw)

d) Pmax = ρ.h.g



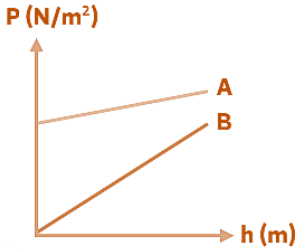
86. The graph represents the relationship between the pressure at a point in the two different fluids A, B and the depth of this point in the fluids. Which of the following choices is correct?

a) $P_{a)} > P_{b)}$, A is exposed to air

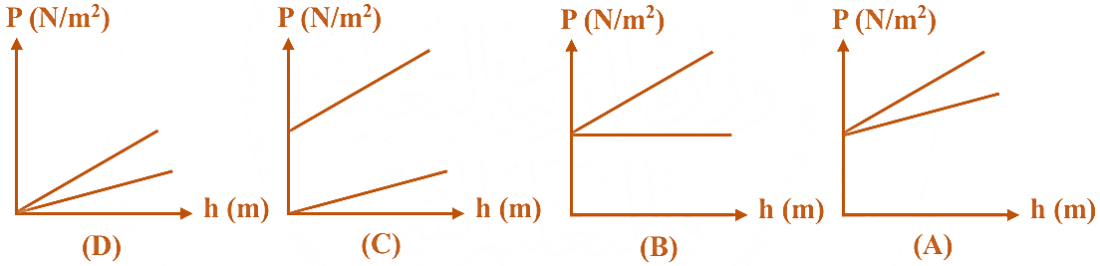
b) $P_{a)} > P_{b)}$, A is not exposed to air

c) $P_{a)} < P_{b)}$, A is exposed to air

d) $P_{a)} < P_{b)}$, A is not exposed to air



87. Two identical tanks containing two liquids. The density of the liquid in the second tank is greater than the density of the liquid in the first tank. The first tank is closed and the second tank is open. The graph shows the pressure (P) and the depth (h). The …



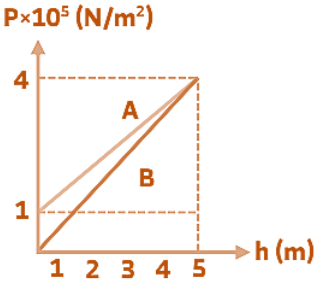
88. In the given graph: A and B are two different liquids. The ratio between density of liquid B and density of liquid A is:

a) 5/4

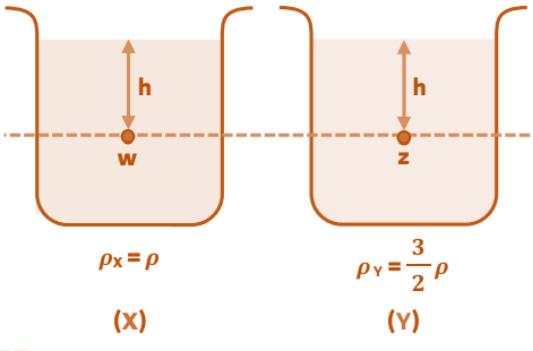
b) 4/5

c) 4/3

d) 3/4



89. Two identical tanks containing two liquids (X, Y) of different densities, the relationship between the pressure at (w) and the pressure at (z) on the same horizontal level is ……..



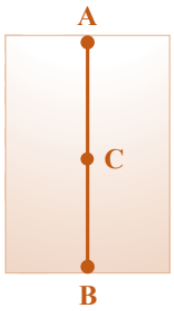
a) Pw = Pz

b) 3Pw = 2Pz

c) 2Pw = 3Pz

d) Pw = 1/2 Pz

90. The figure represents a part of the fluid pressure at point A located at the surface is R where R represents the atmospheric pressure and the pressure difference between A, B is equal to 3R, and point C is located in the middle of the vertical distance between A, B. The value of the pressure at point C is equal to. …..



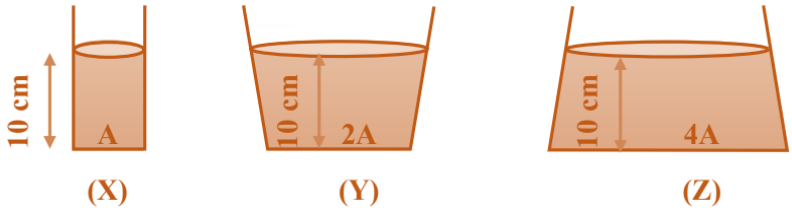
a) (5 R)/2

b) (3 R)/2

c) 3 R

d) 2 R

91. In the figure shown, three vessels are filled with water. The ratio of the force of the water on the base is, in the order Fx: Fy: Fz, which is



a) 10: 20: 15

b) 4: 2: 1

c) 1: 2: 2

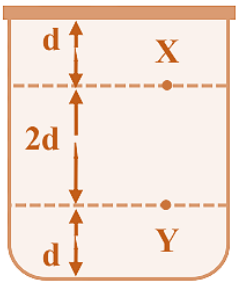
d) 1: 2: 4

82. Two identical tanks, each with a cross-sectional area of A, fill the first with water and the volume of water is 0.6 of the volume of the tank, and fill the second with oil and the volume of oil is 0.7 of the volume of the tank. The ratio between (water pressure at point X)/(oil pressure at point Y) is: (Knowing that the ρ_w = 1000 Kg/m³ and ρ_{oil} = 800 Kg/m³)

a) 4/5 b) 2/25

c) 5/4 d) 15/14

83. In the given figure, a tank is filled with a certain liquid. If the pressure of the liquid at point (X) is 3 bar, then the pressure at point (Y) is ……..



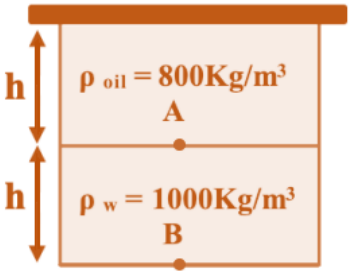
a) 9 bar

b) 4.5 bar

c) 6 bar

d) 12 bar

84. A vessel contains a quantity of water and oil. The ratio between Pressure at point A and Pressure at point B is …….



a) 4/6

b) 4/8

c) 9/10

d) 4/9

85. A wooden table has a top surface with dimensions 1.6 m × 2 m. Calculate the force exerted by atmospheric pressure on the table's surface. (Knowing that Pa = 1.03×10^5 N/m²)

a) 1.013×10^5 N

b) 3.24×10^5 N

c) 0.317×10^5 N

d) 3.24×10^5 N

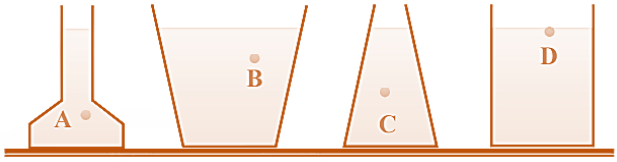
86. A set of containers is filled with water as shown in the figure. Which of the following represents the correct order of pressure at points A, B, C, and D?

a) $P_A > P_B > P_C > P_D$

b) $P_D > P_C > P_B > P_A$

c) $P_A > P_C > P_B > P_D$

d) $P_D > P_B > P_C > P_A$



87. A person is diving in a liquid with a density of 1030 kg/m³. The maximum pressure that can be tolerated without eardrum rupture is 30.6 × 10^4 N/m². Given that atmospheric pressure (Pa) = 1.013 × 10^5 N/m² and g = 9.8 m/s², the maximum depth the diver can reach is:

a) 10.11 m

b) 30.32 m

c) 20.28 m

d) 40.46 m

88. Two bodies (A, B) are placed at two different depths (15 cm, 20 cm) respectively in a closed container filled with water. The ratio between the pressure exerted on body B and the pressure exerted on body A is equal to …….

a) 4/3

b) 3/4

c) 5/4

d) 4/5

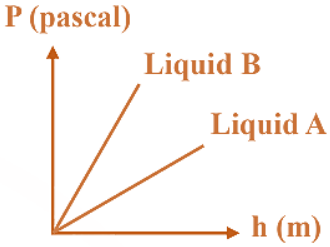
89. The graph shows the relationship between the pressure of two different liquids and the height of the liquid column (h) for two separate experiments. If the slope of straight-line A = 7900 and the slope of straight-line B = 9800. Which of the following choices is correct?

a) $\rho_B > \rho_A$

b) $\rho_A = 2\rho_B$

c) $\rho_A = 9.8\ \rho_B$

d) $\rho_B = \rho_A$



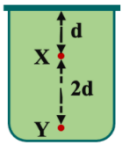
90. A container holds a liquid. The ratio of the pressure at point X to the pressure at point Y is:

a) 2/1

b) 1/3

c) 1/2

d) 1/1



91. A submarine is designed to withstand a maximum pressure of 12.2×10^5 N/m². If the density of seawater is 1030 kg/m³, what is the maximum depth it can safely dive to? Also, if the diameter of its hatch is 100 cm, what is the force acting on the hatch at that depth? (Take g = 9.8 m/s²)

a) Depth = 121 m, Force = 3.8×10^6 N

b) Depth = 121 m, Force = 9.6×10^5 N

c) Depth = 121 m, Force = 9.6×10^5 N

d) Depth = 121 m, Force = 3.8×10^6 N

92. A beaker contains mercury to a height of 5 cm, above which there is a layer of water 10 cm high, and on top of that, a layer of kerosene 2 cm high. Given that the densities of mercury, water, and kerosene are 13600 kg/m³, 1000 kg/m³, and 800 kg/m³ respectively, and the acceleration due to gravity is g = 9.8 m/s². The total pressure exerted by all the liquids on the bottom of the beaker is ……..

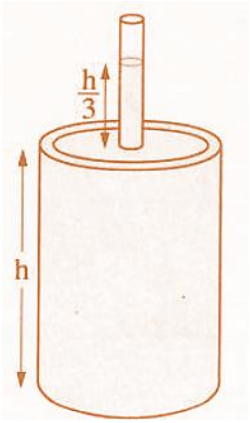
a) 7.81×10^3 N/m²

b) 7.5×10^3 N/m²

c) 8×10^3 N/m²

d) 9.20×10^3 N/m²

93. The opposite figure shows a cylindrical water tank with base area A and height h. A vertical tube is fixed at the top, open at the upper end. If the water rises inside the tube to a height of h/3, then the total pressure acting on the base of the tank equals:



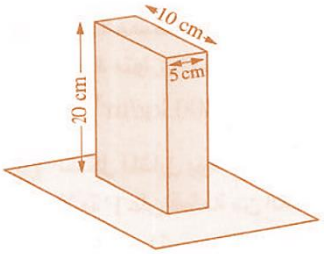
a) $P_a + \frac{1}{3}\rho_w\, g\, h$

b) $3\, \rho_w\, g\, h$

c) $P_a + \frac{4}{3}\rho_w\, g\, h$

d) $\frac{3}{4}\rho_w\, g\, h$

94. In the opposite figure, a rectangular block is placed on a horizontal surface. If its base dimensions are (10 cm × 5 cm), it exerts pressure P on the surface. What is the change in the pressure exerted on the surface when its base dimensions become (20 cm × 10 cm)?



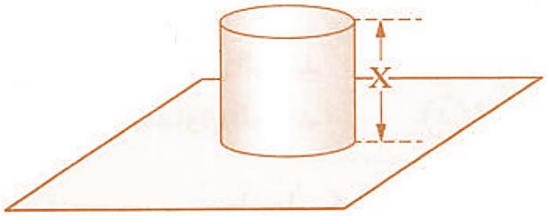
a) increases by P/4

b) decreases by P/2

c) increases by 4P

d) decreases by 3P/4

95. The opposite figure shows a solid metal cylinder of height X and cross-sectional area A placed on a horizontal surface. If the cylinder exerts a pressure P on the smooth surface beneath it, then the density of the cylinder material equals: (Consider g as the gravitational acceleration)



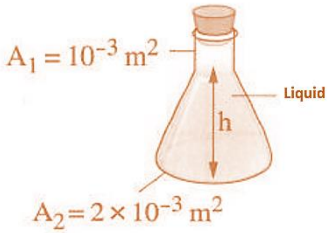
a) gX / P

b) P / gX

c) gX / PA

d) PA / gX

96. A conical flask contains a liquid of density 900 kg/m³ as shown. If the liquid exerts a force of 7.2 N on the base of the flask, then the height of the liquid (h) equals: (g = 10 m/s²)



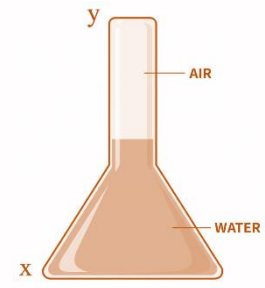
a) 0.1 m

b) 0.3 m

c) 0.4 m

d) 0.8 m

97. A glass tube closed at both ends contains a quantity of water as shown. When placed upright, the pressure of water at the base equals P. When the tube is inverted so that the air pocket becomes at the bottom and the base becomes at Y, the pressure acting on the base at Y becomes:



a) zero

b) less than P

c) equal to P

d) greater than P

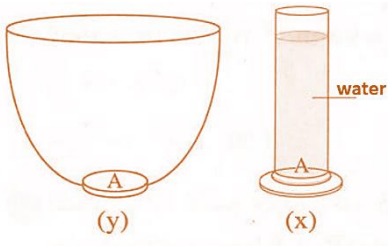
98. In the opposite figure, container X with base area A contains an amount of water causing pressure P at its base. If we pour this water into container Y which has the same base area A, but a different shape, then the pressure of water at the base of Y equals:

a) less than P

b) equal to P

c) greater than P

d) zero



99. If the average radius of Earth is 6.37×10^6 m and the average atmospheric pressure at Earth's surface is 1.013×10^5 Pa, and the surface area of Earth is $4\pi r^2$, and the gravitational acceleration is 9.8 m/s², then the approximate total mass of the atmosphere equals:

a) 3.64×10^{15} kg

b) 5.27×10^{18} kg

c) 8.3×10^{19} kg

d) 9.51×10^{20} kg

100. The opposite figure shows two square papers X and Y lying horizontally under atmospheric pressure. If the area of square X is four times the area of square Y, then the ratio between:

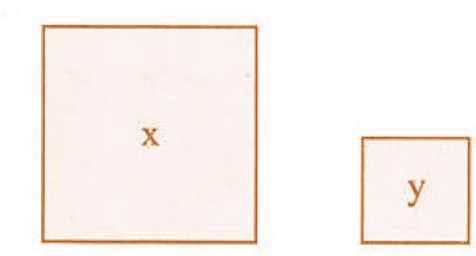
(I) The atmospheric pressure acting on square X and the atmospheric pressure acting on square Y (P_x / P_y) equals:

a) 1 / 1

b) 2 / 3

c) 1 / 4

d) 2 / 1



(II) The atmospheric force acting on square X and the atmospheric force acting on square Y (F_x / F_y) equals:

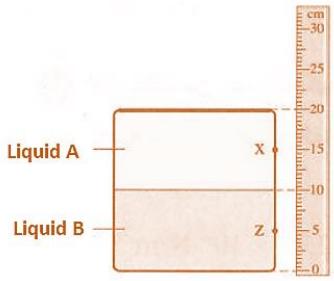
a) 1 / 2

b) 4 / 1

c) 2 / 1

d) 1 / 4

101. The opposite figure shows a closed container containing two liquids A and B whose densities are ρ and 2ρ respectively. If the pressure of liquid at point X equals P, then the pressure of the liquids at point Z equals:



a) 2P

b) 4P

c) 3P

d) 6P

102. What is the pressure difference between the heart and the brain in a giraffe, if the brain is 2m above the heart? (Blood density 1060 kg/m³, assuming constant blood velocity)

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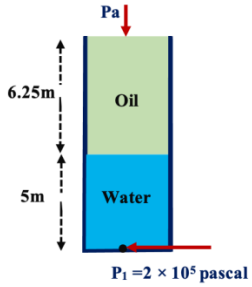
103. From the opposite figure

Calculate the pressure on the surface of the oil

Knowing that ρ_{oil} = 800 Kg/m³, g = 10 m/s², ρ_w = 1000 Kg/m³.



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104. A tank with dimensions 200 cm × 100 cm × 50 cm is filled with water up to a height of 2 m. Calculate:

a) The pressure of the water on the bottom of the tank.

b) The force exerted by the water on the bottom of the tank.

c) The pressure of the water at a point 40 cm above the bottom.

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105. A solid cube and a solid rectangular block are made of the same material. The dimensions of the rectangular block are (10 cm × 20 cm × 30 cm). When the block is placed on a table resting on the face (20 cm × 30 cm), the pressure it exerts is three times the pressure exerted by the cube when placed on the same table. Calculate the side length of the cube.

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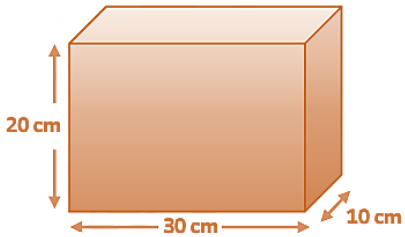
106. A rectangular block has dimensions 25 cm × 20 cm × 10 cm and a density of 2700 kg/m³. It is placed on a horizontal table as shown. Calculate:

a) The pressure exerted by the block.

b) The maximum pressure that the block can exert.

c) How should the block be placed to produce the maximum pressure?



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