Pressure – Pressure at a Point inside a Liquid (CH5-L1)

⚛ Key Concepts

- **Pressure (P)** — The average force acting perpendicular on a unit area.
- **Pressure formula** — $P = \frac{F}{A}$.
- **Pascal (Pa)** — Unit of pressure equal to N / m^2.
- **Pressure at a point inside a liquid** — Caused by the weight of the liquid column above that point.
- **Liquid pressure relation** — $P = \rho g h$.
- **Total pressure inside a liquid exposed to air** — $P = Pa + \rho g h$.
- **Atmospheric pressure (Pa)** — Pressure due to the weight of air columns.

⚖ Comparison / Relationship Tables

Factors Affecting Pressure at a Point inside a Liquid

Factor	Symbol	Effect on Pressure
Density of liquid	ρ	Directly proportional
Depth below surface	h	Directly proportional
Gravity	g	Directly proportional

Pressure at Different Points in the Same Liquid

Condition	Pressure Result
Same depth	Equal pressure
Greater depth	Greater pressure

Liquid Surface Condition and Pressure Formula

Surface Condition	Pressure Expression
Not exposed to air	$P = \rho g h$
Exposed to air	$P = Pa + \rho g h$

Force Exerted by a Liquid

Surface	Relation
Bottom of container	$F = P \times A$
Vertical face	$F = \rho g h_{avg} \times A$

💬 Q & A Section

❓ Why pressure inside a liquid does not depend on container shape?

💬 It depends only on density, depth, and gravity.

❓ Why pressure is a scalar quantity?

💬 It has magnitude only and no direction.

❓ Why dams are thicker at the bottom?

💬 Liquid pressure increases with depth.

❓ Why deep divers need special suits?

💬 To withstand very high pressure at great depths.

❓ Which part of a force produces pressure on a surface?

💬 Only the component of the force perpendicular to the surface produces pressure.

❓ What causes the buoyant force on a body inside a liquid?

💬 It is caused by the difference between the pressures on the lower and upper surfaces of the body.

❓ What is the pressure at the same horizontal level in connected containers?

💬 The pressure is equal at all points on the same horizontal level.

❓ Why is pressure in submarines and airplanes kept nearly constant?

💬 To maintain pressure close to atmospheric pressure for safety.

❓What is the Pressure direction in any point inside the liquid?

💬 Pressure is always acting in all directions in a point inside a liquid

❓What is the force direction on any surface inside the liquid?

💬 Force is always acting perpendicular on any surface inside the liquid

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🚫 Common Mistakes & Exam Traps

⚠️ Forgetting that pressure is generated only from perpendicular force.

⚠️ Forgetting atmospheric pressure when the liquid surface is exposed to air.

⚠️ Thinking pressure at a point depends on container shape or base area.

⚠️ Mixing force with pressure in calculations.

⚠️ Assuming pressure is a vector quantity.

ALL MATHEMATICAL EQUATIONS

Pressure on a Surface

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

When Force is Inclined to the Surface by θ

- $P = \frac{F \sin\theta}{A}$

Pressure Due to Weight of a Solid

- $P = \frac{W}{A}$
- $P = \frac{mg}{A}$

Liquid Pressure at a Point Inside a Liquid

- $P = \rho g h$

Total Pressure in a Liquid Exposed to Air

- $P = P_a + \rho g h$

Atmospheric Pressure Relations

- $P_a = \rho_{air} g h$
- P_a = weight of air column / area

Pressure Difference Between Two Points in a Liquid

- $\Delta P = \rho g \Delta h$
- $P_2 - P_1 = \rho g (h_2 - h_1)$

Force on the Bottom of a Container

- $F = \rho g h A$
- $F = \rho g V$

Average Pressure on a Vertical Surface

- $P_{avg} = \rho g (\frac{h}{2})$

Force on a Vertical Face of a Container

- $F = P_{avg} A$
- $F = (\frac{1}{2}) \rho g h A$

Pressure at Same Horizontal Level

- $P_1 = P_2$ (same liquid, same level)

Pressure Inside Submarines / Divers

- $P_{inside} = P_a$
- $P_{outside} = P_a + \rho g h$

Bubble Pressure in a Liquid

- $P_{bubble} = P_a + \rho g h$

Pressure–Depth Graph Slopes

- $Slope = \frac{\Delta P}{\Delta h} = \rho g$

Pressure Graph Intercepts

- **P = 0 when h = 0** (liquid only)
- **$P = P_a$ when h = 0** (exposed to air)

Applications of Pressure at a Point inside a Liquid (CH5-L2)

⚛ Key Concepts

◆ **Connected vessels** — Vessels of different shapes connected at their bases and containing the same liquid.

◆ **Pressure at same horizontal level** — Pressures at all points on the same horizontal level in a static homogeneous liquid are equal.

◆ **Result in connected vessels** — The liquid surface takes the same horizontal level in all vessels if their bases are at one level.

◆ **U-shaped tube** — A tube bent into a U-shape used to study pressure relations & density of liquids.

◆ **Equilibrium in U-shaped tube** — At equilibrium, pressures at the same horizontal level in the two arms in a homogenous liquid are equal.

◆ **Relative density** — The ratio between the density of a liquid and the density of water.

◆ **Height–density relation** — The height of a liquid column above the separating surface is inversely proportional to its density.

⚖ Comparison / Relationship Tables

U-Shaped Tube at Equilibrium (Two Immiscible Liquids)

Quantity	Liquid 1	Liquid 2
Density	ρ_1	ρ_2
Height above interface	h_1	h_2
Relation	$\rho_1 h_1 = \rho_2 h_2$	
Relation	$\frac{m_1}{A_1} = \frac{m_2}{A_2}$	

Effect of Density on Liquid Level in U-Tube

Liquid Type	Density	Free Surface Level
Less dense	Smaller	Higher
More dense	Larger	Lower

Effect of Tube Dimensions in U-Shaped Tube

Property	Effect on Height Ratio
Tube radius	No effect
Cross-sectional area	No effect

💬 Q & A Section

❓ **Why do liquid levels become equal in connected vessels?**

💬 Because pressure at the same horizontal level is equal in a static liquid.

❓ **Why does the less dense liquid rise higher in a U-shaped tube?**

💬 Because liquid height is inversely proportional to density.

❓ **How can the density of a liquid be determined using a U-tube?**

💬 By comparing its height with another liquid of known density at equilibrium.

❓ **What condition must be met to compare pressures in a U-tube?**

💬 The comparison must be at the same horizontal level in the same liquid.

❓ **How are pressures compared when more than two liquids are present?**

💬 The total pressure is the sum of pressure contributions of all liquid columns.

❓ **Does the amount of liquid affect the height ratio in a U-shaped tube?**

💬 No, the height ratio depends only on the ratio of densities.

❓ **What happens to liquid levels when more liquid is added to one arm?**

💬 One level goes down while the other rises until equilibrium is restored.

❓ **What relation connects displaced liquid volumes in unequal arms?**

💬 Volume displaced downward equals volume displaced upward.

❓ **How are height changes related when arm areas are different?**

💬 Same volume displaced so, $A_1 h_1 = A_2 h_2$.

🚫 Common Mistakes & Exam Traps

⚠️ Comparing pressures at different horizontal levels.
⚠️ Taking horizontal level of different liquids
⚠️ Thinking liquid height depends on tube shape or radius.
⚠️ Forgetting that liquids must be immiscible in U-tube experiments.
⚠️ Assuming denser liquid always has higher level.

ALL MATHEMATICAL EQUATIONS

Equality of Pressure at Two Points in Connected Vessels

- $P_1 = P_2$
- $P_a + \rho g h_1 = P_a + \rho g h_2$
- $h_1 = h_2 = h_3 = \ldots$

U-Shaped Tube (Two Immiscible Liquids at Equilibrium)

- $P_1 = P_2$
- $P_a + \rho_1 g h_1 = P_a + \rho_2 g h_2$
- $\rho_1 h_1 = \rho_2 h_2$

Density Ratio (Relative Density)

- $\frac{\rho_1}{\rho_2} = \frac{h_2}{h_1}$
- $\rho_{relative} = \frac{\rho_{liquid}}{\rho_{water}}$

More Than Two Immiscible Liquids in a U-Tube

- $P_x = P_y$
- $\rho_1 h_1 = \rho_2 h_2 + \rho_3 h_3$

Volume Conservation in U-Tube (Different Cross-Sections)

- $A_1 h_1 = A_2 h_2$

Continuation of Applications of Pressure at a Point inside a Liquid (CH5-L3)

⚛ Key Concepts

- **Atmospheric pressure** — The pressure due to the weight of air columns surrounding the Earth.
- **Mercury barometer** — An instrument used to measure atmospheric pressure using mercury.
- **Torricellian vacuum** — The nearly empty space above the mercury column in a barometer.
- **Standard atmospheric pressure** — Atmospheric pressure equal to the pressure of a mercury column of height 0.76 m at 0°C at sea level.
- **Manometer** — A device used to measure gas pressure using a liquid of known density.

⚖ Comparison / Relationship Tables

Factors Affecting Atmospheric Pressure

Factor	Change	Effect on Atmospheric Pressure
Height above sea level	Increases	Decreases
Average air density	Increases	Increases
Temperature	Increases	Decreases
Acceleration due to gravity	Decreases	Decreases

Mercury Barometer: Structure and Function

Item	Description
Tube	Glass tube, uniform cross-section, closed at one end
Liquid	Mercury
Vacuum	Torricellian vacuum above mercury
Reading	Vertical height of mercury column below Torricellian vacuum down to the mercury surface in the mercury basin

Units Used for Measuring Pressure

Unit	Value of standard Atmospheric Pressure
cm Hg	76
mm Hg	760
m Hg	0.76
atm	1
bar	1.013
N/m^2	1.013×10^5

Manometer Liquid Level and Gas Pressure

Liquid Level in Open Arm	Gas Pressure Relation
Same level	Gas pressure equals atmospheric pressure
Higher level	Gas pressure greater than atmospheric pressure
Lower level	Gas pressure less than atmospheric pressure

Comparison of Pressure Measuring Devices

Device	Used Liquid	Main Use
U-shaped tube	Two immiscible liquids	Compare densities
Barometer	Mercury	Measure atmospheric pressure
Manometer	Mercury or water	Measure gas pressure

💬 Q & A Section

❓ **Why is mercury used in barometers?**

💬 Because its opaque, has high density gives a suitable column height and its vapor pressure is negligible.

❓ **Why does atmospheric pressure decrease with altitude?**

💬 Because the length and weight of the air column above decrease.

❓ **Why must the barometer tube be vertical?**

💬 Because the pressure depends on the vertical height of the mercury column.

❓ **What happens to mercury height if the barometer is inclined?**

💬 The vertical height remains the same.

$$h_{vertical} = h_{inclined} \times \sin\left(\theta_{between\ the\ mercury\ surface\ and\ tube}\right)$$

❓ **Why is water not suitable for barometers?**

💬 Because its low density requires a very long tube and has high vapor pressure, and adhere to surface.

❓ **Why does trapped air affect barometer readings?**

💬 Because mercury pressure alone represents atmospheric pressure only when no air is present.

If air present: $P_a = h_{Hg} + P_{trapped\ air}$

❓ **Why are water manometers preferred for small pressure differences?**

💬 Because their lower density produces noticeable level differences.

❓ **Why are mercury manometers used for larger pressure differences?**

💬 Because mercury's high density keeps level differences small and measurable.

❓ **What happens to barometer reading if air is partially evacuated?**

💬 The mercury height decreases and the Torricellian vacuum increases.

❓ **How to measure the height of building using manometer?**

💬 $\rho_{air}\, h_{building} = \rho_{Hg}(h_{barometer\ down} - h_{barometer\ up})$

❓ **What are the two values of blood pressure and what do they indicate?**

💬 Contraction pressure (maximum, 120 torr) and relaxation pressure (minimum, 80 torr); change in either indicates illness.

❓ **How does air pressure inside a car tyre affect friction and temperature?**

💬 High pressure decreases contact area and friction; low pressure increases contact area, friction, and tyre temperature.

🚫 Common Mistakes & Exam Traps

⚠️ Measuring inclined length instead of vertical height in a barometer.

⚠️ Assuming trapped air has no effect in barometer readings.

⚠️ Using water instead of mercury for atmospheric pressure measurement.

⚠️ Barometer reading is incorrect if you can't see Torricellian vacuum

⚠️ Liquids don't get sucked, it gets pushed.

ALL MATHEMATICAL EQUATIONS

Standard Atmospheric Pressure Values

$@\ 0°C\ \&\ Sea\ level$

- P_a = 76 cm Hg
- P_a = 760 mm Hg
- P_a = 0.76 m Hg
- P_a = 1 atm
- P_a = 1.013 bar
- $P_a = 1.013 \times 10^5\ N/m^2$
- P_a = 1013 milliBar

Determining Height Difference Using Barometer

- $\rho_{air}\ h_{mountain} = \rho_{Hg}\ (h_1 - h_2)$
- $h_{mountain} = \frac{\rho_{Hg}\ (h_1 - h_2)}{\rho_{air}}$

Unit Conversion Relations

- Pressure in req. unit = $Old \times \frac{new_{atm}}{old_{atm}}$

Trapped Air in Capillary Tube

- $P = P_a$ (horizontal tube ==)
- $P = P_a + h$ (open up +)
- $P = P_a - h$ (open down -)

Pressure at a Point Inside Multiple Fluids

- $P = P_a + \rho_1 g h_1 + \rho_2 g h_2$

Pressure of Enclosed Gas (General Case)

- $P_{gas} = P_a + \rho\ g\ \Delta h$

Healthy Blood Pressure Values

- Contraction pressure = 120 torr
- Relaxation pressure = 80 torr

Pascal's Principle (CH5-L4)

Key Concepts

◆ **Pascal's principle** — When pressure is applied to a liquid enclosed in a container, it is transmitted fully to all parts of the liquid and the container walls.

◆ **Hydraulic press** — A device that uses Pascal's principle to obtain a large force from a small force.

◆ **Efficiency of hydraulic press** — Ratio of work done by the big piston to work done by the small piston.

◆ **Mechanical advantage (η)** — The force amplification achieved by a hydraulic press. (unitless)

$$\eta = \frac{F}{f} = \frac{A}{a} = \frac{R^2}{r^2} = \frac{D^2}{d^2} = \frac{y_2}{y_1}$$

Comparison / Relationship Tables

Structure of the Hydraulic Press

Part	Description
Small piston	Small cross-sectional area
Big piston	Large cross-sectional area
Liquid	Incompressible hydraulic liquid
Tube	Connects both pistons

Pressure Relation in Hydraulic Press (Same Level)

Piston	Force	Area	Radius	Diameter	Displacement
Small piston	f	a	r^2	d^2	y1
Big piston	F	A	R^2	D^2	y2

Displacement Relation in Hydraulic Press

Quantity	Small Piston	Big Piston
Displacement	Large	Small
Force	Small	Large
Direction	Downwards	Upwards

Cases of Hydraulic Press Stability

Condition	Pressure Relation
Pistons at same level	$P_1 = P_2$
Pistons at different levels	$P_1 = \rho g h + P_2$

Applications of Pascal's Principle

Device	Application
Hydraulic press	Lifting heavy loads
Hydraulic brakes	Stopping cars
Hydraulic lift	Lifting vehicles
Dentist chair	Adjusting height
Hydraulic drill	Construction work

💬 Q & A Section

❓ Why is Pascal's principle applied to liquids, not gases?

💬 Because liquids are incompressible, while gases are compressible and pressure is not fully transmitted.

❓ Why does the big piston move a smaller distance?

💬 Because work done by both pistons is equal and volume displaced is the same ($A \propto \frac{1}{h}$).

❓ Why doesn't the hydraulic press multiply energy?

💬 Because work output equals work input according to conservation of energy.

❓ Why the efficiency of a real hydraulic press is less than 100%?

💬 Due to friction and presence of gas bubbles in the liquid.

🚫 Common Mistakes & Exam Traps

⚠️ Forgetting liquid height effect when pistons are at different levels.

⚠️ Assuming hydraulic press multiplies energy.

⚠️ Mixing Pressure ratio with Force ratio.

⚠️ Mechanical advantage is always larger than 1

ALL MATHEMATICAL EQUATIONS

◆ Pressure Produced by Pistons
(at same horizontal level)

- $P_1 = P_2$
- $P = \frac{f}{a}$, $P = \frac{F}{A}$
- $\frac{f}{a} = \frac{F}{A}$

◆ Displacement–Area Relation

- $Vol_1 = Vol_2$
- $A\, y_2 = a\, y_1$
- $\frac{y_1}{y_2} = \frac{A}{a}$

◆ Hydraulic Press
(Different Horizontal Levels)

- $P_1 = P_2$

(where 1 & 2 are two points on the same level)

- $\frac{f}{a} = \frac{F}{A} + \rho g h$
- $\frac{f}{a} + \rho g h = \frac{F}{A}$

◆ Ideal Hydraulic Press
(Energy Conservation)

- $Work_{small\ piston} = Work_{big\ piston}$
- $f\, y_1 = F\, y_2$

◆ Mechanical Advantage of Hydraulic Press

- $\eta = \frac{F}{f} = \frac{A}{a} = \frac{R^2}{r^2} = \frac{D^2}{d^2} = \frac{y_1}{y_2}$
- $\eta > 1$

◆ Graph Relations

- Slope = $\Delta F / \Delta f = \eta$
- Slope = $\Delta y_2 / \Delta y_1 = 1 / \eta$

◆ Efficiency of Hydraulic Press

- $Efficiency = \frac{F\, y^2}{f\, y^1} = \frac{Work\ big\ piston}{work\ smal\ piston}$

Boyle's Law (CH6-L1)

⚛️ Key Concepts

◆ **Motion of gas molecules** — Gas molecules move in continuous random translational motion in all directions.

◆ **Brownian motion** — Random continuous motion of small particles suspended in a fluid due to collisions with gas molecules.

◆ **Intermolecular spaces** — Large distances separating gas molecules compared with solids and liquids.

◆ **Compressibility of gases** — Gases are highly compressible due to large intermolecular spaces.

◆ **Gas variables** — The state of a gas is determined by pressure (P), volume (V), and temperature (T).

◆ **Boyle's law** — For a fixed mass of gas at constant temperature, volume is inversely proportional to pressure.

◆ **Boyle's law statement** — At constant temperature, the product of pressure and volume of a gas is constant.

⚖️ Comparison / Relationship Tables

Molecular Motion in Different States of Matter

State	Type of Motion	Description
Solid	Vibrational	Around fixed positions
Liquid	Vibrational + translational	Limited movement
Gas	Random translational	Free motion in all directions

Properties of Gases

Property	Cause	Result
Brownian motion	Random particle motion	Continuous collisions
Large intermolecular spaces	Weak attraction	Easy diffusion
High compressibility	Large empty spaces	Volume decreases on pressure

Gas State Change with Variables

State	Temperature Change	Pressure Change
Solid & liquid	Volume changes	Nearly no change
Gas	Volume changes	Volume changes

Boyle's Law Graphical Relations

Graph	Shape	Meaning
V – P	Curve	Inverse relation
V – 1/P	Straight line	Direct proportionality

Conditions of Boyle's Law Experiment

Condition	How	Purpose
Constant temperature	Moving piston slowly	Isolate pressure–volume relation
Fixed gas mass	Trapping air	Validity of law

Q & A Section

What produces gas pressure inside a container?

Continuous collisions of gas molecules with the walls of the container.

What causes Brownian motion?

Continuous random collisions between gas molecules and suspended particles.

How does gas density change when volume increases at constant temperature?

Gas density decreases as volume increases.

Why must the tube in Boyle's experiment have uniform cross-section?

So the length of the trapped gas represents its volume.

ALL MATHEMATICAL EQUATIONS

Boyle's Law Core Equations

- $P_1V_1 = P_2V_2$
- $\frac{P_1}{\rho_1} = \frac{P_2}{\rho_2}$

Boyle's Apparatus Relations

- $V \propto L$ (because tube has uniform cross-section)
- $P_{gas} = P_{atm} \pm h$

$P = P_{atm} + h \, (gas\ compressed)$

$P = P_{atm} - h \, (gas\ expanded)$

Gas Mixing at Constant Temperature

- $P_{mix} V_{total} = P_1 V_1 + P_2 V_2$

Balloon Explosion inside a Container

- Volume before explosion

  $V_{container} - V_{balloon}$
- After explosion:

  $V_{mix} = V_{container}$
- $P_{mix} V_{mix} = P_1 V_1 + P_2 V_2$

Rising Bubble in a Liquid (Boyle + Liquid Pressure)

- $P_1 V_1 = P_2 V_2$
- $P_1 = P_{atm} + \rho g h$
- $P_2 = P_{atm}$

Charles's Law (CH6-L2)

⚛ Key Concepts

🔷 **Charles's law** — At constant pressure, the volume of a fixed amount of gas is directly proportional to its absolute temperature.

🔷 **Absolute zero** — The temperature at which the volume of a gas theoretically becomes zero at constant pressure.

🔷 **Volume expansion coefficient of a gas (α_v)** — The increase in gas volume per unit original volume at 0°C for 1°C rise in temperature at constant pressure equals to 1/273 K^{-1}.

🔷 **Equality of gas expansion** — Equal volumes of different gases expand by the same amount for the same temperature rise at constant pressure.

⚖ Comparison / Relationship Tables

Temperature Scales Relation

Scale	Zero Point	Relation
Celsius (°C)	−273	t = T − 273
Kelvin (K)	0	T = t + 273

Graphs Used in Charles's Law

Graph	Shape	Meaning
V vs t (°C)	Straight line	Cuts x-axis at −273
V vs T (K)	Straight line	Starts from origin

Conditions of Charles's Law Experiment

Condition	How	Purpose
Constant pressure	Trapping air by mercury pellet	Validity of law
Fixed gas mass	Trapped air	Accurate relation

💬 Q & A Section

❓ **Why must temperature be measured in Kelvin?**

💬 Because volume is directly proportional to absolute temperature, not Celsius temperature.

❓ **Why does the V–t graph cut the axis at −273°C?**

💬 Because this temperature corresponds to absolute zero.

❓ **Why does Charles's law not apply if pressure changes?**

💬 Because volume then changes due to pressure, not temperature only.

❓ **Why is pressure constant in the experiment?**

💬 Because the trapped gas is always exposed to atmospheric pressure.

❓ **Why is mercury used to trap the air column?**

💬 Because it forms a clear seal and does not mix with air.

❓ **Why does gas volume increase when heated?**

💬 Because gas molecules move faster and occupy a larger volume.

❓ **What is the relation between temperature change in Kelvin and Celsius?**

💬 ΔT(K) = Δt(°C).

❓ **What is the slope of the V–T graph equal to?**

💬 ΔV / ΔT = V_0 / 273.

❓ **Why can Charles's law be applied to a gas in an open container?**

💬 Because its pressure remains equal to atmospheric pressure.

🔢 ALL MATHEMATICAL EQUATIONS

🔷 **Temperature Conversion**

- **T = t + 273**
- **t = T – 273**
- **ΔT = Δt**

🔷 **Volume Expansion at Constant Pressure**

- **$\Delta V \propto \Delta t$**
- **$\Delta V \propto V_0$**
- **$\Delta V \propto V_0 \Delta t$**

🔷 **Volume Expansion Coefficient (α_v)**

- $\alpha_v = \frac{\Delta V}{V^0 \Delta t}$
- $\alpha_v = \frac{Vt - V^0}{V^0 \Delta t}$
- $\alpha_v = \frac{V_{100} - V_0}{V_0 \times 100}$
- $\alpha_v = \frac{1}{273} \; K^{-1}$

🔷 **Charles's Law (Basic Relations)**

- **$V \propto T$**
- **V / T = constant**
- $\frac{V_1}{T_1} = \frac{V_2}{T_2}$

🔷 **Graphical Relations**

- **Slope = ΔV / ΔT**
- **Slope = V_0 / 273**

🔷 **Density–Temperature Relations (Constant Pressure)**

- $\rho = \frac{m}{V}$
- $\rho \propto \frac{1}{V}$
- $\rho \propto \frac{1}{T}$
- $\rho_1 T_1 = \rho_2 T_2$

🔷 **Volume Expansion Coefficient from Two Temperatures**

- $\left(\frac{V_1}{V_2}\right) = \frac{1 + t_1 \alpha_v}{1 + t_2 \alpha_v}$

Gay-Lussac's Law (for Pressure) & General Law of Gases (CH6-L3)

⚛ Key Concepts

🔷 **Gay-Lussac's law (for pressure)** — At constant volume, the pressure of a fixed amount of gas is directly proportional to its absolute temperature.

🔷 **Pressure increasing coefficient (βp)** — The increase in gas pressure per unit original pressure at 0°C for 1°C rise in temperature at constant volume equals 1/273 K^{-1}.

🔷 **Absolute zero** — The temperature at which the pressure of an ideal gas theoretically becomes zero at constant volume.

🔷 **General law of gases** — For a fixed mass of gas, the product of pressure and volume divided by absolute temperature is constant.

🔷 **Ideal gas** — A gas that obeys gas laws exactly and whose pressure or volume theoretically vanishes at absolute zero.

⚖ Comparison / Relationship Tables

Graphs Used in Gay-Lussac's Law

Graph	Shape	Meaning
P vs t (°C)	Straight line	Cuts x-axis at −273
P vs T (K)	Straight line	Starts form origin

Comparison of Gas Laws

Law	Constant Quantity	Relation
Boyle's law	Temperature	P × V = constant
Charles's law	Pressure	V / T = constant
Gay-Lussac's law	Volume	P / T = constant

💬 Q & A Section

❓ Why must volume be constant in Gay-Lussac's law?

💬 Because pressure must depend on temperature only.

❓ Why is Kelvin used in pressure–temperature relations?

💬 Because pressure is directly proportional to absolute temperature.

❓ Why does the P–t graph cut the axis at −273°C?
💬 Because pressure theoretically becomes zero at absolute zero.

❓ Why is βp the same for all gases?
💬 Because equal pressure increase occurs for equal temperature rise.

❓ When is Charles's law applied instead of Gay-Lussac's law?
💬 When the gas is open to air and pressure is constant.

❓ What does the slope of P–T graph represent?
💬 The ratio P_0 / 273.

❓ Why does pressure increase when temperature rises at constant volume?
💬 Because gas molecules collide more frequently with container walls.

❓ When can the general law of gases be used?
💬 When pressure, volume, and temperature all change together.

ALL MATHEMATICAL EQUATIONS

Gay-Lussac's Law
(Pressure–Temperature at Constant Volume)

- $\frac{P_1}{T_1} = \frac{P_2}{T_2}$

Pressure increasing coefficient (βp)

- $\beta_p = \frac{\Delta P}{P_0 \Delta t}$
- $\beta_p = \frac{P_t - P_0}{P_0 t}$
- $\beta_p = \frac{1}{273}\ K^{-1}$

Pressure change with temperature

- $\Delta P = \beta_p P_0 \Delta t$

Graph relations

- Slope = ΔP / ΔT
- Slope = $\frac{P_0}{273}$

General Law of Gases

- $\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$
- $\frac{P_1}{\rho_1 T_1} = \frac{P_2}{\rho_2 T_2}$

Standard Temperature and Pressure (STP)

- $P_{STP} = 1.013 \times 10^5\ N/m^2 = 76\ cm\ Hg$
- $T_{STP} = 273\ K = 0°\ C$

Bubble in a Liquid (Combined Law Use)

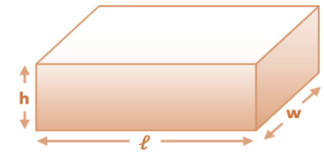
- $\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$
- $P1 = P_a + \rho\, g\, h$
- $P2 = P_a$

Questions

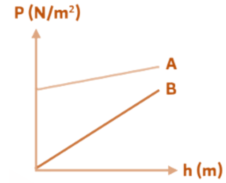
Chapter 5

1. 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

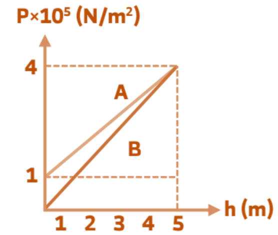
2. A cuboid with dimensions (ℓ, w, h) is placed on a horizontal surface as shown in the figure. The maximum pressure exerted on the surface can be calculated from the relationship
   (A) Pmax = Fg/(w.h)
   (B) Pmax = ρ.w.g
   (C) Pmax = Fg/(L.w)
   (D) Pmax = ρ.h.g



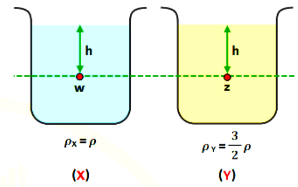
3. The graph represents the relationship between the pressure at a point in the two different fluids A, B and the depth of this point in the fluids. Which of the following choices is correct?
   (A) ρ(A) > ρ(B), A is exposed to air
   (B) ρ(A) > ρ(B), A is not exposed to air
   (C) ρ(A) < ρ(B), A is exposed to air
   (D) ρ(A) < ρ(B), A is not exposed to air



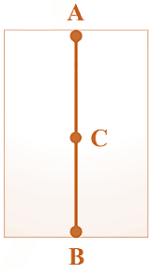
4. In the given graph: A and B are two different liquids. The ratio between density of liquid B and density of liquid A is:
   (A) 5/4
   (B) 4/5
   (C) 4/3
   (D) 3/4



5. 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

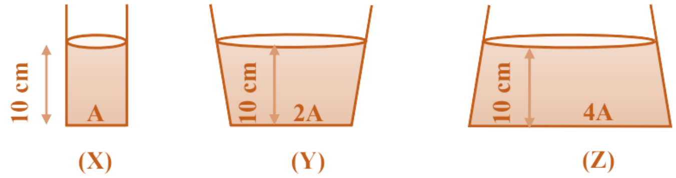


6. The figure represents a part of the fluid pressure at point A located at the surface is R where R represents the atmospheric pressure and the pressure difference between A, B is equal to 3R, and point C is located in the middle of the vertical distance between A, B. The value of the pressure at point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



(A) (5R)/2
(B) (3R)/2
(C) 3R
(D) 2R

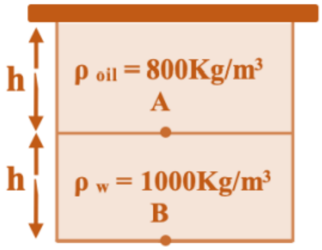
7. In the figure shown, three vessels are filled with water.
The ratio of the force of the water on the base is, in the order FX : FY : FZ, which is
(A) 10 : 20 : 15
(B) 4 : 2 : 1
(C) 1 : 2 : 2
(D) 1 : 2 : 4



8. 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 $\rho w = 1000\ Kg/m^3$ and $\rho oil = 800\ Kg/m^3$)
(A) 4/5
(B) 2/25
(C) 5/4
(D) 15/14

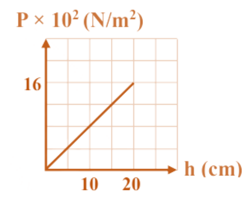
9. A tank with dimensions 200 cm × 100 cm × 50 cm is filled with water up to a height of 2 m. Calculate:
(a) The pressure of the water on the bottom of the tank.
(b) The force exerted by the water on the bottom of the tank.
(c) The pressure of the water at a point 40 cm above the bottom.

10. 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

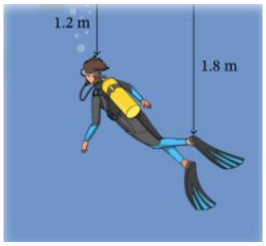


11. A person is diving in a liquid with a density of 1030 kg/m³.
The maximum pressure that can be tolerated without eardrum rupture is 30.6×10^4 N/m².
Given that atmospheric pressure (Pa) = 1.013×10^5 N/m² and g = 9.8 m/s², the maximum depth the diver can reach is:
(A) 10.11 m
(B) 30.32 m
(C) 20.28 m
(D) 40.35 m

12. The figure shows the relationship between the pressure at several points within the liquid and their depths.
Given that the acceleration due to gravity is g = 10 m/s², the density of the liquid is:
(A) 800 kg/m³
(B) 0.8 kg/m³
(C) 8000 kg/m³
(D) 0.16 kg/m³



13. 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



14. A diver swims in water with a density of 1015 kg/m³, as shown in the figure. Calculate the difference in water pressure between the diver's head and feet.

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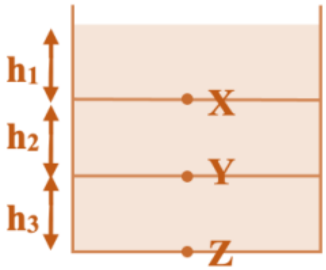
15. The figure shows containers filled with a liquid of density ρ, under gravitational acceleration g, and liquid heights $h_1 = h_2 = h_3$.
The pressures at points X, Y, and Z are:
(A) Px > Py > Pz
(B) Px = 3Pz = 2Py
(C) Pz > Py > Px
(D) Py = 2Pz = 3Px



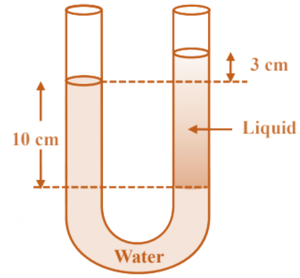
16. At a point inside a liquid, the pressure:
    (A) Acts only in the downward direction
    (B) Acts equally in all directions and increases with depth
    (C) Acts parallel to the surface of the liquid
    (D) Decreases with the depth of the liquid

17. 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 km, Force = 9.6×10^5 N
    (C) Depth = 121 m, Force = 9.6×10^5 N
    (D) Depth = 121 km, Force = 3.8×10^6 N

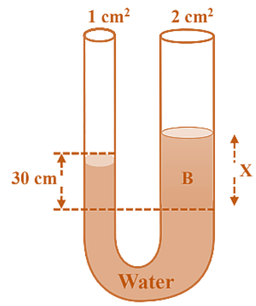
18. A beaker contains mercury to a height of 5 cm, above which there is a layer of water 10 cm high, and on top of that, a layer of kerosene 2 cm high.
    Given that the densities of mercury, water, and kerosene are 13600 kg/m³, 1000 kg/m³, and 800 kg/m³ respectively, and the acceleration due to gravity 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

19. From the opposite figure, the relative density of the liquid is .....



    (A) 13/10
    (B) 10/13
    (C) 3/10
    (D) 11/3

20. If the relative density of liquid B is 0.8, the value of x equals....

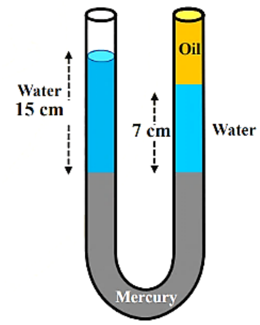


    (A) 37.1 cm
    (B) 37.2 cm
    (C) 37 cm
    (D) 37.5 cm

21. A U-shaped tube with two branches, the cross-sectional area of one branch is twice that of the other. Oil was poured into the wide branch, so the distance between the water surfaces in the two branches became 10 cm and the height of the oil became 12 cm. Then the relative density of the oil is

(A) 1.6
(B) 1.2
(C) 0.86
(D) 0.83

22. From the opposite figure:
If you know that the density of oil and water are = 800 Kg/m^3, 1000 Kg/m^3 respectively. Then the height of the oil column is equal to. .....



(A) 9 cm
(B) 12 cm
(C) 10 cm
(D) 8 cm

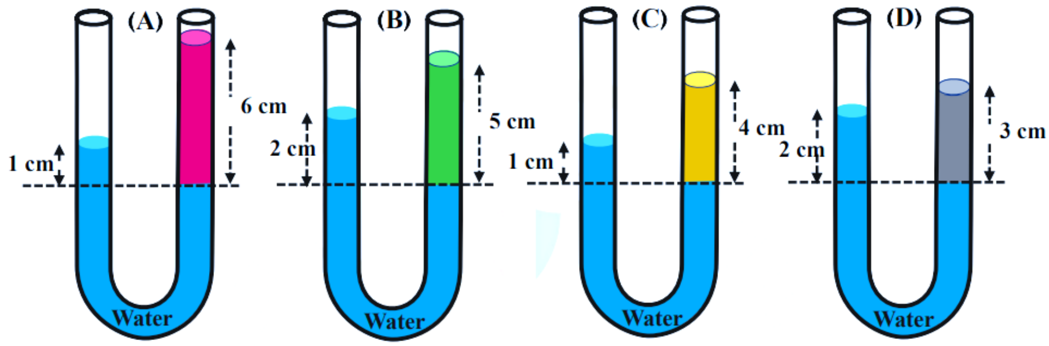
23. A U-shaped tube, the ratio of the cross-sectional areas of the tube is 1:2.
The tube contains a quantity of mercury. When a quantity of water is poured into one of its branches, the ratio of the height of the water to the height of the mercury above the separating surface between the mercury and the water is equal to. . . ..

(A) Half the relative density of mercury.
(B) The relative density of mercury.
(C) Twice the relative density of mercury.
(D) The reciprocal of the relative density of mercury

24. In a U-shaped tube with uniform cross-section containing water, oil is poured into one of its arms. If the relative density of the oil is 0.8 and the height of the oil column is 20 cm, the distance between the upper surfaces of the oil and the water is ….

(A) 8 cm
(B) 4 cm
(C) 20 cm
(D) 16 cm

25. The figure represents U-shaped tubes for measuring the densities of different liquids, where the left branch in the tube contains water with a density of 1000 kg/m³.



Which of the following tubes has a relative density of liquid of 0.4?

(A) A.
(B) B.
(C) D.
(D) C.

26. A U-shaped tube of uniform cross-section contains water. Oil is then poured into one arm, causing the water surface to drop by 1.5 cm. The height of the oil column equals
Given that ρ_o = 800 kg/m³ and ρw = 1000 kg/m³.

(A) 1.875 cm
(B) 3.75 cm
(C) 3.5 cm
(D) 3.875 cm

27. A U-shaped tube with two uniform branches, its cross-sectional area is 2 cm², and it contains oil with a density of 900 kg/m³. Alcohol was poured into one of its branches, so the surface of the oil in it decreased by 6 cm. If the height of the alcohol above the level of the separating surface is 13.69 cm, then the mass of the alcohol...........

(A) 0.216 Kg
(B) 21.6 Kg
(C) 2.16 g
(D) 21.6 g

28. In a U-shaped tube of uniform cross-section there is a quantity of mercury. Oil is poured into one arm and water is poured into the other until the mercury surfaces in the two arms are at the same horizontal level. The measured difference between the heights of the water and oil columns is 4 cm. Calculate the height of each of the oil and water columns, given that the relative density of the oil is 0.8 and the density of water is 1000 kg·m^{-3}.

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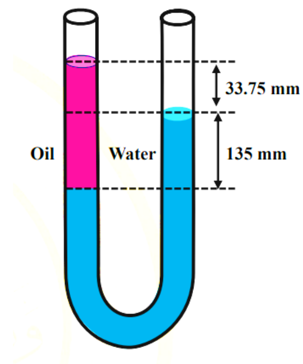
29. From the opposite figure:

If you know that the radius of the tube is 1 cm, and the density of water is 1000 Kg/m^3.

Calculate

(a) the density of the oil and the weight of the oil column.

(b) the weight of the water column above the separating surface level.



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30. A U-shaped tube, where the cross-sectional area of one arm is twice that of the other. The tube contains water. Oil with a density of 900 kg/m^3 is poured into the wider arm, causing the water surface in that arm to drop by 0.5 cm. Calculate the height of the oil above the separating surface, assuming the density of water is 1000 kg/m^3.

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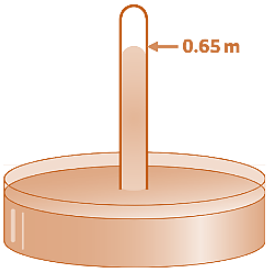
31. If the atmospheric pressure at sea level is 76 cmHg, and the temperature decreases significantly during winter on a very cold night, which of the following values represents the atmospheric pressure in winter?
(A) 0.8 mHg
(B) 1 atm
(C) 0.9 bar
(D) 750 Torr

32. If the difference in air pressure inside a flying aircraft and outside it is 0.1 atm, then it is equivalent to .....
(A) 7.6 mHg
(B) 0.076 mHg
(C) 0.76 mHg
(D) 76 mHg

33. The figure shows a mercury barometer placed in a location to measure the atmospheric pressure there. The barometer reading indicates that it is placed …



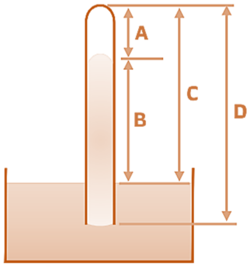
(A) In a valley between two mountains
(B) At sea level
(C) On the top of a mountain
(D) At the bottom of a deep well

34. A solid rectangular prism whose material has a density of 2700 $kg \cdot m^{-3}$, and whose dimensions are 40 cm, 30 cm, 20 cm, with the acceleration due to gravity $g = 10\ m \cdot s^{-2}$, has a maximum pressure of:
(A) 1.08 bar
(B) 0.108×10^5 bar
(C) 0.0108 bar
(D) 0.108 bar

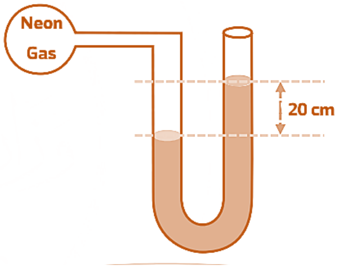
35. If the usual atmospheric pressure is 76 cm Hg, and a hurricane causes the atmospheric pressure to decrease by 10%, then the new atmospheric pressure becomes:
(A) 0.684 m Hg
(B) 68.4 m Hg
(C) 0.076 m Hg
(D) 7.6 m Hg

36. Which of the following factors does not affect the height of the mercury column in a barometer:
(A) Mercury density
(B) Cross-sectional area of the tube
(C) Acceleration due to gravity
(D) Atmospheric pressure

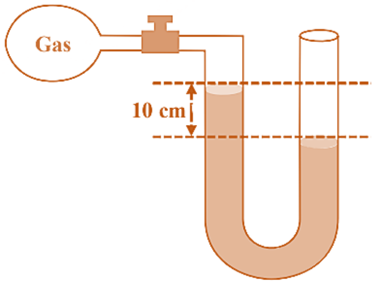
37. In the opposite figure, the atmospheric pressure in the mercury barometer is equal to the height ....
(A) A
(B) B
(C) C
(D) D



38. In the opposite figure, a mercury manometer is connected to a closed arm containing some neon gas. Given that the atmospheric pressure is 760 mm Hg, the pressure of the neon gas is ....
(A) 780 cm Hg
(B) 78 cm Hg
(C) 96 cm Hg
(D) 960 cm Hg



39. The figure shows a manometer whose tube contains water of density 1000 kg/m³, with $g = 9.8$ m/s², and the gas pressure in the reservoir is $P_{(gas)} = 1.003 \times 10^5$ N/m². The atmospheric pressure acting on the open end of the manometer is ....
(A) 0.84 atm
(B) 0.92 atm
(C) 0.98 atm
(D) 1.06 atm



40. When water is replaced by mercury in a manometer that measures a small pressure difference, the resulting liquid column height becomes ....
(A) greater
(B) smaller
(C) Does not change
(D) Increases by the same ratio by which the density decreases
41. In an open-ended manometer, the sign of the height difference between the liquid levels in the two arms (h) is positive when the gas pressure in the reservoir becomes ....
(A) Less than atmospheric pressure
(B) Greater than atmospheric pressure
(C) Equal to atmospheric pressure
(D) Greater than atmospheric pressure by an amount that causes the liquid to rise only in the open arm without change in the closed arm

42. A tower has a height of 90 m. If the atmospheric pressure at ground level is 76 cm Hg, and the density of air is 1.25 kg/m^3, the density of mercury is 13600 kg/m^3, and g = 9.8 m/s^2, calculate the atmospheric pressure at the top of the tower

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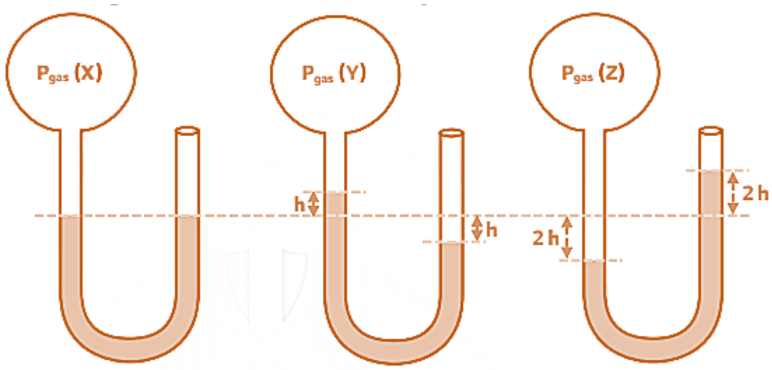
43. The figure shows three identical manometers, each connected to a reservoir containing a different gas: X, Y, and Z.



The gas whose pressure is equal to atmospheric pressure is ....

The correct order of the pressures of the enclosed gases is ....

44. What is the reading of a barometer placed on the top of a mountain with a height of 5.1 km above sea level, if its reading at sea level is 0.75 m Hg?

Given: the density of air is 1.2 kg/m^3, and the density of mercury is 13600 kg/m^3.

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45. If the standard atmospheric pressure is 1 atm, and a person climbs a skyscraper carrying a barometer, then notices that the pressure at one of the floors has decreased by 5%, which of the following choices represents the correct barometer reading?

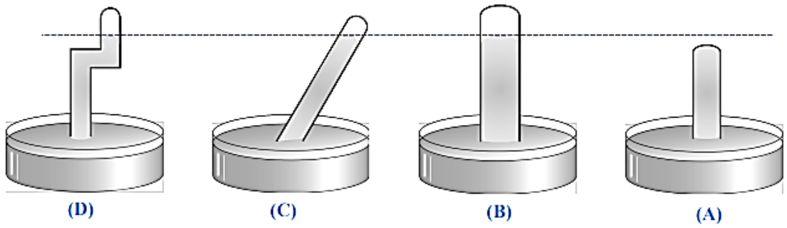
(A) 74.2 cm Hg

(B) 73.2 cm Hg

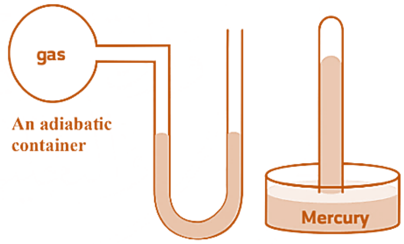
(C) 72.2 cm Hg

(D) 75.2 cm Hg

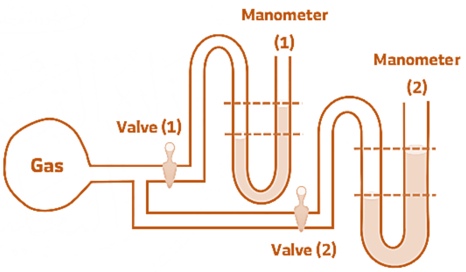
46. All of the following barometers can be used to measure atmospheric pressure except …



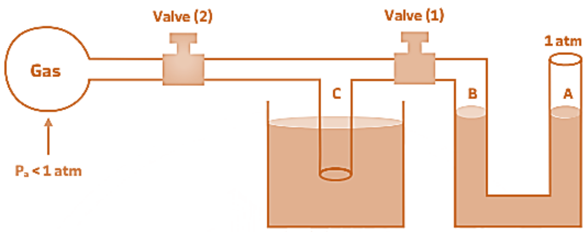
47. The ratio between the length of the Torricellian vacuum in a barometer at the top of a mountain and its length at the bottom of the mountain is ………………
    (A) Greater than one
    (B) Less than one
    (C) Equal to one
    (D) Increases as atmospheric pressure decreases
48. The two figures represent a mercury barometer and a mercury manometer at sea level. If both devices are taken to the top of a mountain, then:
    The height of the mercury column in the barometer will ………………
    The height of the mercury column in the open arm of the manometer will ………………



49. The figure shown represents two manometers connected to a gas reservoir. If the two manometers differ in the radius of their tubes and contain different liquids, which of the following reasons explains the difference in the liquid-level displacement in the two manometers?
    (A) The radius of manometer (1) is smaller than the radius of manometer (2).
    (B) The density of the liquid in manometer (1) is greater than the density of the liquid in manometer (2).
    (C) The density of the liquid in manometer (1) is less than the density of the liquid in manometer (2).
    (D) Valve (1) is higher than valve (2).

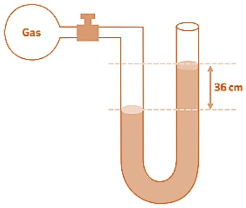


50. A barometer reads 76 cm Hg at the bottom of a building and 75.8 cm Hg at the top. If the average density of air is 1.36 kg/m³, then the height of the building equals ………
    (A) 12 m
    (B) 20 m
    (C) 54 m
    (D) 150 m
51. What happens to the mercury level at points A, B, and C when valves 1 and 2 are opened in the diagram?
    (A) C rises while B falls and A rises
    (B) A and B remain constant while C falls
    (C) C remains unchanged, while A and B rise
    (D) A falls, while B and C rise



52. A gas is confined in its container at a pressure of 1.267 atm. One student wants to measure this pressure using a water manometer, while another student wants to measure it using a mercury manometer. Which measurement will be more accurate, knowing that atmospheric pressure is 10^5 N/m²?
(A) Measurement using the water manometer is more accurate
(B) Measurement using the mercury manometer is more accurate
(C) Both give the same degree of accuracy
(D) Accuracy depends only on the value of atmospheric pressure, not on the type of manometer
53. If a U-tube manometer is used with a wider tube, the manometer reading will ……
(A) Decrease
(B) Increase
(C) Remain constant
(D) Depend only on the tube cross-sectional area, unrelated to the pressure difference
54. In a test to measure the air pressure inside the lungs, Waleed blew with all his strength into one end of a mercury manometer, causing the mercury in the free (open) arm to rise 5 cm relative to the limb connected to Waleed. What is the pressure inside his lungs?
Given: atmospheric pressure = 1.013×10^5 $N \cdot m^{-2}$, mercury density = 13600 $kg \cdot m^{-3}$, gravitational acceleration g = 10 $m \cdot s^{-2}$.
(A) 1.02×10^5 Pa
(B) 1.08×10^5 Pa
(C) 1.15×10^5 Pa
(D) 1.34×10^5 Pa
55. When the top of the mercury barometer tube (Torricelli's vacuum) is broken, the height of the mercury column in the tube will ………………
(A) Remain as it is
(B) Increase and spill out of the tube
(C) Fall to the level of the mercury in the reservoir
(D) Oscillate briefly and then return to its original height
56. Pressure 800 cm Hg ………… pressure 0.08 bar.
(A) Greater than
(B) Less than
(C) Equal to
(D) Cannot be compared without converting units

57. The figure represents a mercury manometer containing a gas whose pressure is 100 cm Hg. Calculate the atmospheric pressure acting on the open end of the manometer in atm.



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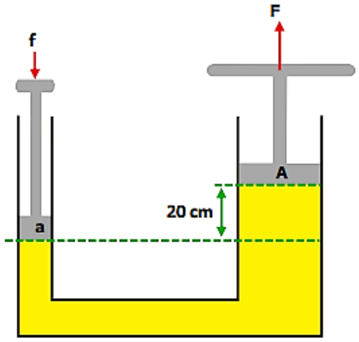
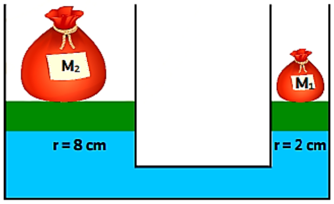
58. If the area of the small piston is 80 cm² and the area of the large piston is 0.1 m², the density of the oil used is 860 kg/m³, and the force applied to the small piston is 200 N, then the pressure directly beneath the large piston equals .... (g = 10 m/s²)



(A) 23280 N/m²
(B) 25000 N/m²
(C) 1720 N/m²
(D) 1900 N/m²

59. A hydraulic press is balanced in the shown position. Which of the following relations is correct? (Given that g = 10 m/s²)



(A) $M_2 = 8\ M_1$
(B) $M_2 = 6\ M_1$
(C) $M_2 = 16\ M_1$
(D) $M_2 = 10\ M_1$

60. In a car-wash hydraulic lift, if the diameter of the small piston is 4 cm and the diameter of the large piston is 40 cm, the pressure required to lift a car of mass 2000 kg equals … (Given g = 10 m/s²)

(A) 1.59×10^2 N/m²   (B) 1.59×10^3 N/m²
(C) 1.59×10^4 N/m²   (D) 1.59×10^5 N/m²

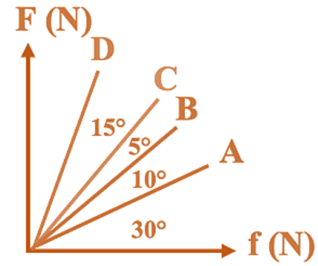
61. The pressure under the small piston equals the pressure under the large piston in a hydraulic press when ....

(A) the two pistons are at the same horizontal level
(B) the small piston is at a higher level than the large piston
(C) the large piston is at a higher level than the small piston
(D) the fluid between the pistons contains gas bubbles

62. In an ideal hydraulic press, which of the following ratios equals one?

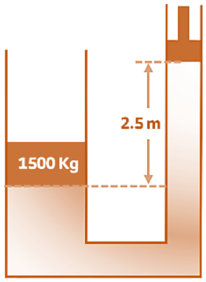
(A) pressure on the large piston to pressure on the small piston
(B) work done on the small piston to work output by the large piston
(C) force applied to the small piston to force produced on the large piston
(D) displacement of the small piston to displacement of the large piston

63. In an ideal hydraulic press, which of the following ratios is greater than one?
    (A) The pressure under the large piston to the pressure under the small piston
    (B) The work done on the small piston to the work output by the large piston
    (C) The speed of motion of the small piston to the speed of motion of the large piston
    (D) The time of motion of the small piston to the time of motion of the large piston
64. If the ratio between the radii of two cylindrical pistons in a hydraulic press is 2:7, and both pistons are at the same horizontal level, then the ratio of the pressure under the large piston to the pressure under the small piston equals ………
    (A) 7:2
    (B) 49:4
    (C) 4:49
    (D) 1:1
65. When plotting the graph of the output force on the large piston (F) against the input force on the small piston (f) for a hydraulic press, which of the illustrated graphs is correct?



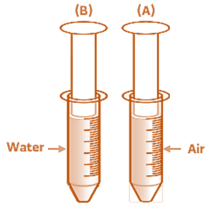
    (A) A
    (B) B
    (C) C
    (D) D
66. A hydraulic press has piston radii of 2 cm and 8 cm. A force of 100 N is applied to the small piston. ($g = 10\ m/s^2$)
    The maximum mass that can be lifted --- The mechanical advantage
    (A) 40 Kg - 4
    (B) 80 Kg - 8
    (C) 160 Kg - 16
    (D) 320 Kg - 32
67. In an ideal hydraulic press, the oil originally used (density = 900 kg/m^3) is replaced by another fluid of density 1800 kg/m^3. The mechanical advantage of the press …………
    (A) increases to double
    (B) decreases to half
    (C) increases four times
    (D) remains the same

68. In the hydraulic press shown: if the mass of the large cylinder is 1500 kg and its cross-sectional area is 0.2 m², the cross-sectional area of the small piston (assumed massless) is 40 cm², and the press is completely filled with oil of specific density = 0.8. What is the force that must be applied to the small piston so that equilibrium occurs? (Take $g = 10\ m/s^2$)



(A) 180 N
(B) 200 N
(C) 220 N
(D) 260 N

69. In the figure, two plastic syringes are shown. When piston (A) is pressed, it moves downward, while when piston (B) is pressed, it does not move. Explain why



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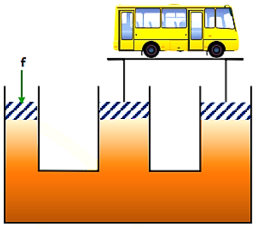
70. Two pistons are used to lift a bus of mass 3 tons, each having a cross-sectional area of 0.1 m², and both are connected to a third piston on which a force of 200 N is applied. Calculate the cross-sectional area of the small piston.



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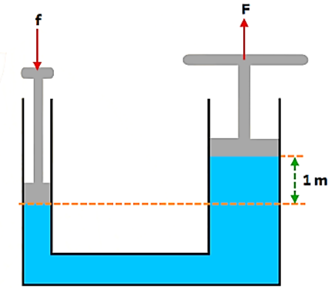
71. In the shown figure: given that $\rho_w = 1000\ kg/m^3$ and $g = 10\ m/s^2$, the pressure at the small piston is greater than the pressure at the large piston by ....



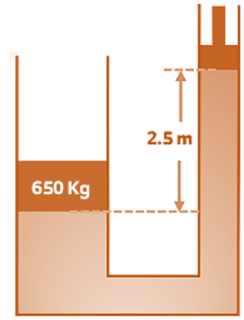
(A) 100 N/m²
(B) 1000 N/m²
(C) 10000 N/m²
(D) 10 N/m²

72. If the ratio between the radii of the two cylindrical pistons in a hydraulic press is 9/2, then the ratio of the output force on the large piston to the input force on the small piston equals

(A) 9/2
(B) 81/4
(C) 4/81
(D) 1/1

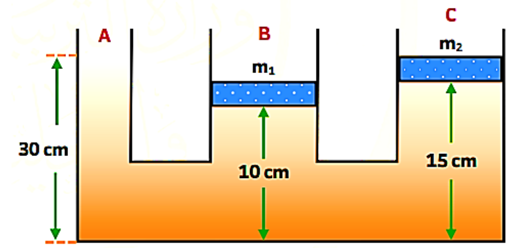
73. A hydraulic press has a large piston whose cross-sectional area is ten times that of the small piston. If a force of 100 N is applied to the small piston, the force exerted on the large piston equals …………
    (A) 2000 N
    (B) 1000 N
    (C) 100 N
    (D) 10 N
74. A hydraulic press has a small piston area of 10 cm^2 and a large piston area of 200 cm^2. It is required to lift a load of mass 1 ton using this press. If 20% of the energy is lost as thermal energy due to friction between the pistons, what is the force that must be applied to the small piston in this case? (Assume $g = 9.8\ m/s^2$)
    (A) 490 N
    (B) 600 N
    (C) 612.5 N
    (D) 784 N
75. A hydraulic press has an efficiency of 98%. The physical quantity represented by the remaining 2% (the loss percentage) is ……….
    (A) Pressure
    (B) Work
    (C) Force
    (D) Displacement
76. If the cross-sectional area of the large piston in a hydraulic press is three times the cross-sectional area of the small piston, what is the ratio of the volume of fluid displaced downward in the small piston's cylinder to the volume of fluid displaced upward in the large piston's cylinder during operation?
    (A) 1:3
    (B) 3:1
    (C) 1:9
    (D) 1:1
77. When a large pressure is applied to a liquid confined inside a thin-walled metal container, the container may bulge or burst because the pressure is transmitted completely through the liquid. This is explained by ___________.
    (A) Boyle's Law
    (B) Pascal's Principle
    (C) Newton's Third Law
    (D) Newton's Second Law

78. In the hydraulic press shown, the mass of the large piston is 650 kg and its cross-sectional area is 0.1 m^2. The cross-sectional area of the small piston is 15 cm^2 and its mass is negligible. The press is completely filled with oil of relative density 0.8. The value of the force (f) required for equilibrium equals ………..



(A) 220 N
(B) 150 N
(C) 67.5 N
(D) 30 N

79. If the cross-sectional areas of pistons A, B, and C are 5 cm^2, 12 cm^2, and 8 cm^2 respectively, and the system is filled with water, find:



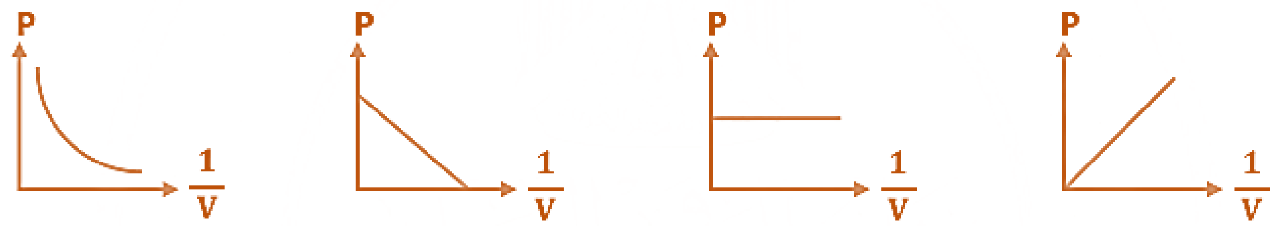
(a) The unknown masses m1 and m2.
(b) The water pressure at the bottom.

……………………………………………………………………………………………………
……………………………………………………………………………………………………
……………………………………………………………………………………………………

Chapter 6

80. The motion of carbon particles present in the gas rising from a burning candle is …………..
(A) Vibrational in its position
(B) Vibrational
(C) Translational in one direction
(D) Random translational in all directions

81. Which of the following graphical shapes expresses the relationship between the pressure of a fixed quantity of gas (P) and the reciprocal of its volume (1/V), at constant temperature? …………..

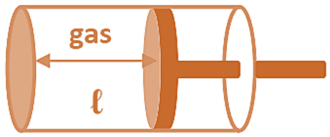


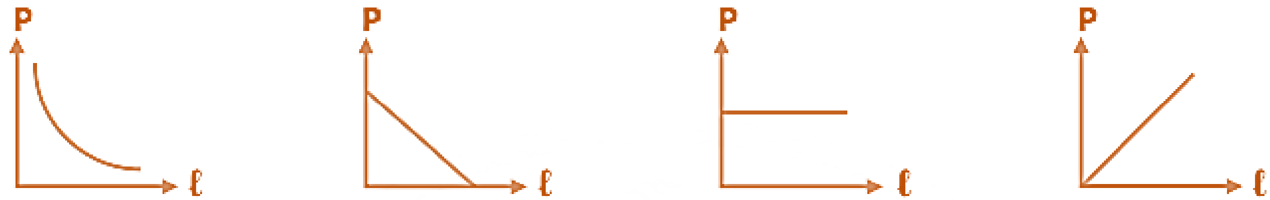
(A) (B) (C) (D)

82. The volume of a gas bubble increases while rising from the bottom of a lake to the water surface because of …………..
(A) Decrease of water pressure
(B) Decrease of water temperature
(C) Decrease of gas mass inside the bubble
(D) Increase of air density inside the bubble

83. A gas has a volume of 4 L and a pressure of 80 cm·Hg. When its volume is reduced to 1 L at constant temperature, its pressure becomes ....
(A) 80 cm·Hg
(B) 160 cm·Hg
(C) 240 cm·Hg
(D) 320 cm·Hg

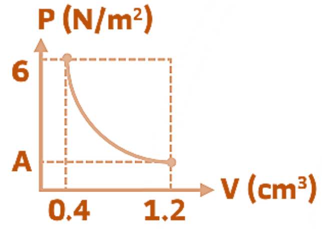
84. The opposite figure shows a uniform cylindrical container provided with a freely moving frictionless piston. Which of the following graphical relations represents the change between the length of the trapped gas column and its pressure? ....





(A) (B) (C) (D)

85. The opposite figure represents the relationship between the volume of a fixed quantity of gas and its pressure. According to the given graph, the value of (A) equals ....



(A) 1 N/m^2
(B) 2 N/m^2
(C) 2.5 N/m^2
(D) 3 N/m^2

86. An air bubble at a depth of 1.43 m in a lake whose water density is 1 g/cm^3 rises to the surface, and its radius doubles. Assuming constant temperature and taking $g = 10\ m/s^2$, the atmospheric pressure at that time equals ....
(A) 1.02×10^3 Pa
(B) 2.04×10^3 Pa
(C) 4.08×10^3 Pa
(D) 1.01×10^5 Pa

87. A completely evacuated bottle was connected to another bottle of volume 500 cm^3 containing gas at a pressure of 20 kPa. The pressure of the gas in the two bottles became 5 kPa. The volume of the evacuated bottle equals ....
(A) 300 cm^3
(B) 500 cm^3
(C) 1250 cm^3
(D) 1500 cm^3

88. A sample of gas has a volume (V) and a pressure of 5 atm. Calculate its pressure if its volume is reduced by one quarter.

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89. A rubber balloon containing trapped air of volume 500 cm^3 and pressure 2 atm is placed in a cubic container of side length 10 cm, then the container is tightly closed. Calculate the final pressure inside the container when the balloon bursts, neglecting the volume of the rubber and assuming constant temperature.

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90. If the pressure of a gas is doubled, its volume becomes .... at constant temperature.
    (A) Decreases to half
    (B) Increases to double
    (C) Decreases to one third
    (D) Increases to three times
91. Two flasks of equal volume are connected by a tube with a valve. One flask contains gas at high pressure, while the other is completely evacuated. When the valve is opened, the compressed gas spreads into both flasks. Which physical quantity does not change? ....
    (A) Pressure
    (B) Volume
    (C) Density
    (D) Mass
92. A reservoir of volume 20 mL is completely evacuated and connected to a bottle containing gas at a pressure of 8 atm. When the valve between them is opened, the pressure decreases by 75%. Assuming constant temperature, the volume of the bottle equals ....
    (A) 2 mL
    (B) 4.67 mL
    (C) 6.67 mL
    (D) 8.67 mL
93. A sample of gas has a volume V and a pressure of 5 atm. If its volume is reduced by one quarter, its pressure becomes ....
    (A) 1.25 atm
    (B) 2.5 atm
    (C) 6.67 atm
    (D) 20 atm

94. 8 L of nitrogen gas at a pressure of 76 cm·Hg is mixed with 16 L of hydrogen gas at a pressure of 75 cm·Hg in a closed container of capacity 20 L. Find the pressure of the mixture assuming constant temperature.

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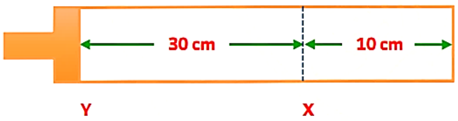
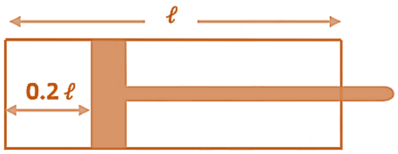
95. A quantity of air is trapped inside a cylinder with a piston as shown. If the piston is pulled from position (X) to position (Y) without changing the temperature, the pressure of the air inside the cylinder ....



(A) Decreases to one quarter
(B) Decreases to one third
(C) Increases to four times
(D) Does not change

96. A container containing gas at pressure Pa is connected through a valve to another container whose capacity is three times the first and is completely evacuated. When the valve is opened, the pressure in the two containers becomes ....
(A) Pa
(B) 1/2 Pa
(C) 2 Pa
(D) 3/4 Pa

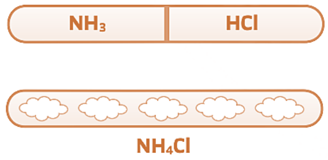
97. The opposite figure shows a uniform cross-section cylinder closed at both ends with a frictionless, area less piston. Two quantities of air at the same pressure are trapped on both sides. If the piston moves to the middle of the cylinder, the ratio of the pressure of the air on the right side to that on the left side equals ....



(A) 1/4
(B) 4/1
(C) 5/8
(D) 8/5

98. If the pressure of a fixed quantity of gas doubles at constant temperature, the volume ....
(A) Doubles
(B) Decreases to half
(C) Remains constant
(D) Decreases to one quarter

99. In the opposite figure, two glass tubes are shown: one contains cotton soaked with ammonia solution and the other contains cotton soaked with hydrochloric acid. When the separating barrier is removed, a white cloud forms inside the tubes. The reason for the formation of the white cloud is ....



(A) Condensation of water vapor inside the tube
(B) Condensation of NH_3 gas inside the tube
(C) Diffusion of both gases into each other's intermolecular spaces
(D) Condensation of HCl gas inside the tube

100. A capillary tube of uniform cross-section contains a mercury thread of length 2 cm that traps a quantity of air. When the tube is placed vertically with its opening upward, the length of the trapped air column is 19 cm. When it is inverted, the length of the trapped air column becomes 20 cm. Calculate the atmospheric pressure at that time.

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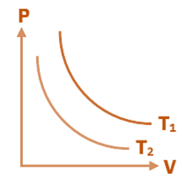
101. In the opposite figure: a relationship to verify Boyle's law is shown. The experiment was carried out at two temperatures T_1 and T_2. Then ....



(A) $T_1 = T_2$
(B) $T_1 > T_2$
(C) $T_1 = 0.5\ T_2$
(D) $T_1 < T_2$

102. The cause of the random motion of smoke particles in air is due to the difference in pressure acting on their sides by air molecules which themselves move randomly. What is the cause of this motion? ....
(A) Collision of randomly moving air molecules with smoke particles
(B) Difference in temperature between the smoke and the air
(C) Effect of the Earth's magnetic field on smoke particles
(D) Air rotation in one fixed direction

103. A gas bubble of volume 5 cm³ at a depth of 10.34 m below the surface of a freshwater lake of density 1000 kg/m³. Calculate its volume when it reaches the water surface, assuming constant temperature. Given:
Atmospheric pressure = 1.013×10^5 N/m² - Acceleration due to gravity g = 9.8 m/s²

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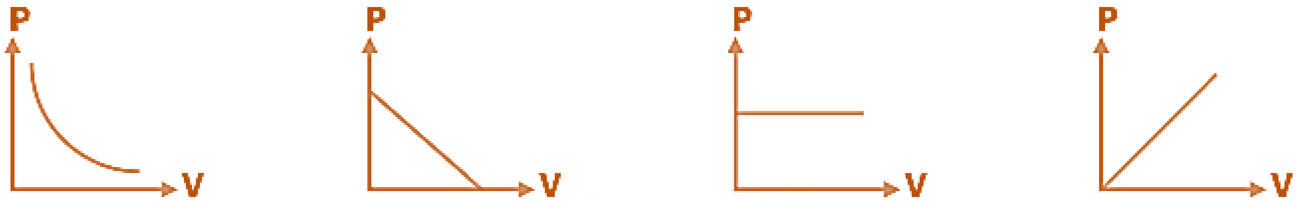
104. The correct graphical shape that represents the relationship between the pressure of a fixed quantity of gas and its volume, at constant temperature, is ....



(A) (B) (C) (D)

105. If the volume of a given amount of gas at 0°C is 450 cm^3, its volume at 91°C, assuming constant pressure, is ....

(A) 321 cm^3

(B) 421 cm^3

(C) 600 cm^3

(D) 333.5 cm^3

106. Which graph correctly represents the relationship between the absolute temperature of a gas and its coefficient of volumetric expansion at constant pressure?

(D) (C) (B) (A)

107. Which mathematical expression correctly represents the relationship between the temperature of a given amount of gas on the Celsius scale and its volume at constant pressure?

(A) $\frac{Vol_1}{Vol_2} = \frac{t_2}{t_1}$ (B) $\frac{Vol_1}{Vol_2} = \frac{1+\alpha_v t_1}{1+\alpha_v t_2}$

(C) $\frac{Vol_1}{Vol_2} = \frac{t_1}{t_2}$ (D) $\frac{Vol_1}{Vol_2} = \frac{1+\alpha_v t_2}{1+\alpha_v t_1}$

108. A gas sample has volume 4 L at 100°C. The required change in temperature (in kelvins) to reduce its volume to quarter of its initial value is ....

(A) 25 K (B) 75 K

(C) 93.25 K (D) 279.75 K

109. If the absolute temperature of a gas increases by 20%, its volume ....

(A) decreases by 20% (B) increases by 20%

(C) decreases by 25% (D) increases by 25%

110. If the volume of a given amount of gas at 0°C equals 1 L, the temperature required to increase the gas volume by 1 L (at constant pressure) is ....

(A) 273°C

(B) 373°C

(C) 273 K

(D) 373 K

111. An open vessel contains a gas of volume 273 cm^3 at 0°C. The volume of gas that leaves the vessel if the vessel is heated by 0.5 K is ....

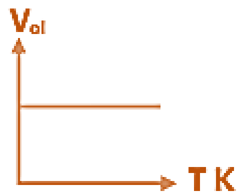
(A) 136.5 cm^3

(B) 0.5 cm^3

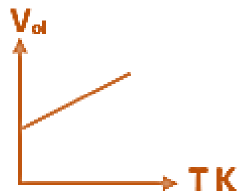
(C) 273.5 cm^3

(D) 3.6×10^{-3} cm^3

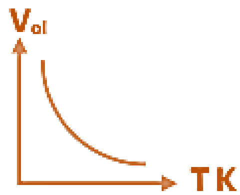
112. Which graph correctly represents the relationship between the volume of a given amount of gas and its temperature at constant pressure?



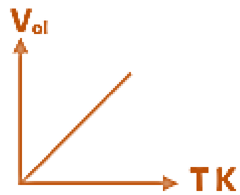
(D)



(C)



(B)



(A)

113. A gas has a volume of 200 cm^3 at 27°C. Calculate: its volume at 77°C

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114. In Charles's experiment to determine the coefficient of volumetric expansion of a gas at constant pressure, the length of the air column was 12 cm when the tube was immersed in crushed ice, and it became 16.4 cm at 100°C.

Calculate: the value of the coefficient of volumetric expansion of the gas at constant pressure.

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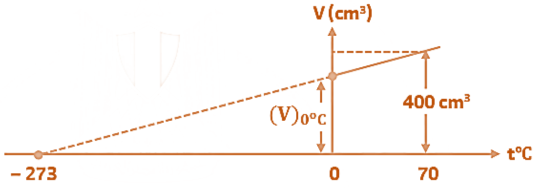
115. The opposite graph represents the relationship between the volume V of a given amount of gas and its temperature in degrees Celsius (t°C). From the graph, the value of V(0°C) is ....

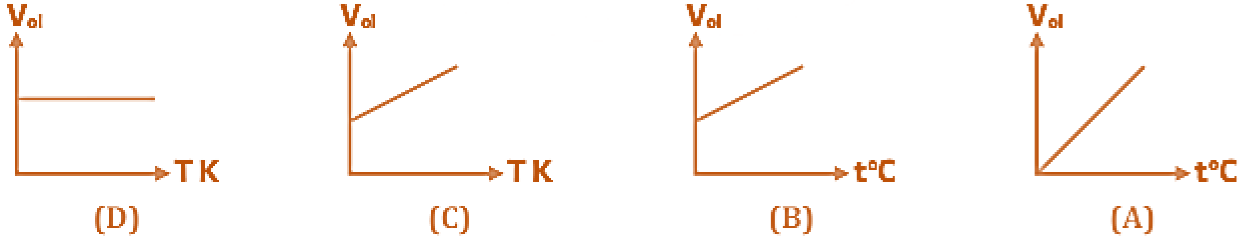


(A) 275.7 cm³
(B) 546.5 cm³
(C) 318.4 cm³
(D) 373.2 cm³

116. A quantity of gas at 25°C is heated to 30°C while its pressure remains constant, and its volume increases by 1.5 cm³. Its original volume is ....
(A) 70.4 cm³
(B) 81.9 cm³
(C) 89.4 cm³
(D) 90.4 cm³

117. The correct mathematical expression of Charles's law is ....
(A) P · Vol = Constant
(B) Vol / T = Constant
(C) P / T = Constant
(D) P Vol / T = Constant

118. The correct graph that represents the relationship between the volume of a given amount of gas and its temperature at constant pressure is ....



119. If the change in volume of a certain mass of gas is 21.978 cm³, and the change in temperature at constant pressure is 60°C, given that the original volume of the gas at 0°C is 100 cm³, then the coefficient of volumetric expansion of the gas at constant pressure is ....
(A) 3.66 K^{-1} (B) 0.366 K^{-1}
(C) 0.0366 K^{-1} (D) 0.00366 K^{-1}

120. The increase in volume of a given amount of gas at constant pressure depends on .....
(A) The volume of the gas at 0°C and the change in the gas temperature
(B) The volume of the gas at 0°C and the type of gas
(C) The change in the gas temperature and the type of gas
(D) It is constant for all gases

121. **A given quantity of gas has a volume of 1 L. If its temperature is increased by 1°C at constant pressure, the increase in its volume will be ....

(A) 273 L

(B) 0.00366 L

(C) 373 L

(D) 0.00268 L

122. The coefficient of volumetric expansion of a gas at constant pressure is equal to ....

(A) 1 / 273 K (B) 1 / 273 K^{-1}

(C) −1 / 273 K^{-1} (D) 1 / 273 °C

123. A capillary tube of length 20 cm contains a 5 cm thread of mercury that traps a quantity of air whose length is 10 cm at 30°C. The maximum temperature that can be measured with this tube without the mercury spilling out is ....

(A) 318°C

(B) 45°C

(C) 454.5°C

(D) 181.5°C

124. A quantity of gas at a temperature of 17°C is heated by 100°C while its pressure remains constant, causing its volume to increase by 2.5 cm³.

Calculate: its volume before heating.

....

....

....

125. A rigid container contains a quantity of dry oxygen gas whose pressure is 72 cm·Hg at a temperature of 7°C. Its pressure at a temperature of 87°C becomes equal to ....

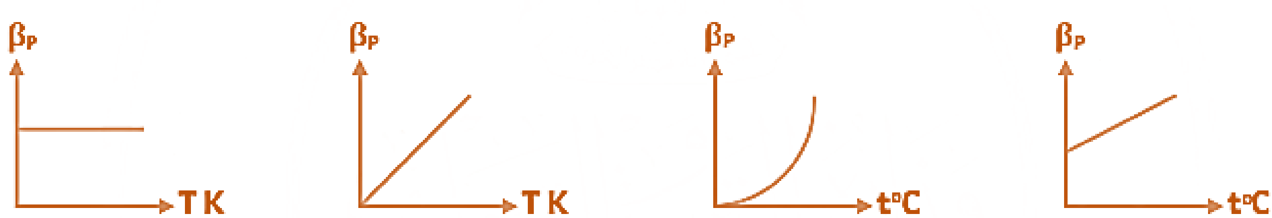
(A) 92.571 cm·Hg

(B) 894.85 cm·Hg

(C) 487.234 cm·Hg

(D) 94.212 cm·Hg

126. The graphical shape that expresses the relationship between the absolute temperature of a gas and the coefficient of increase in the gas pressure at constant volume is ....



(A) (B) (C) (D)

127. The mathematical expression that correctly represents the relationship between the temperature of a given quantity of gas on the Celsius scale and its pressure at constant volume is ....

(A) $\frac{P_1}{P_2} = \frac{t_2}{t_1}$ (B) $\frac{P_1}{P_2} = \frac{1+\beta_p t_1}{1+\beta_p t_2}$

(C) $\frac{P_1}{P_2} = \frac{t_1}{t_2}$ (D) $\frac{P_1}{P_2} = \frac{1+\beta_p t_2}{1+\beta_p t_1}$

128. A quantity of gas has a pressure P at a temperature t°C. Its temperature is raised to 121.5°C, causing its pressure to increase by an amount equal to 0.315 P. The value of t°C equals ....

(A) 300°C
(B) 27°C
(C) 327°C
(D) 315°C

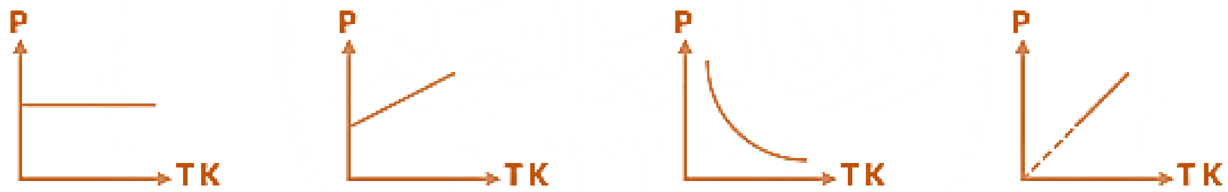
129. A quantity of gas at STP If its pressure increases by three times its initial pressure while its volume remains constant, then its absolute temperature ....

(A) Increases to four times its value
(B) Decreases to one quarter
(C) Remains constant
(D) Increases to three times its value

130. A quantity of gas has a pressure of 40 mm·Hg at a temperature T K. If its temperature increases by 20%, then its pressure becomes ....

(A) 44 mm·Hg
(B) 42 mm·Hg
(C) 52 mm·Hg
(D) 48 mm·Hg

131. The correct graphical shape that represents the relationship between the pressure of a given quantity of gas and its temperature at constant volume is ....



(A) (B) (C) (D)

132. Two containers, one of volume 13 L containing hydrogen under a pressure of 21 cm·Hg, and the other of volume 14 L containing nitrogen under a pressure of 39 cm·Hg. The temperature of both is 0°C. The final pressure of the gas mixture when the two containers are connected and their temperature is raised to 87°C becomes ....

(A) 30 cm·Hg

(B) 20 cm·Hg

(C) 50 cm·Hg

(D) 40 cm·Hg

133. A quantity of nitrogen gas of volume 100 m^3 at a temperature of 27°C and a pressure of 15 atmospheric pressures was compressed to fill an empty container of volume 50 m^3. If the final temperature of nitrogen is 17°C, calculate: the absolute pressure inside the container.

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134. Two glass bulbs of volumes 200 cm^3 and 500 cm^3 respectively are connected by a short capillary tube and tightly sealed under a pressure of 76 cm·Hg at 27°C. Calculate: the pressure of the trapped air when the larger bulb is heated to 127°C while the temperature of the smaller bulb remains 27°C.

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135. A container contains trapped gas whose pressure is 150 cm·Hg at a temperature of 25°C. If the gas pressure decreases to become equal to atmospheric pressure, then the percentage decrease in the gas temperature in kelvin degrees equals ....

(Given: Pa = 76 cm·Hg)

(A) 49.5%

(B) 49.1%

(C) 49.7%

(D) 49.3%

136. A gas has a pressure of 0.5 atm at a temperature of 35°C. Its pressure at a temperature of 85°C equals ....

(A) 5.89×10^4 N/m²

(B) 48.08 cm·Hg

(C) 440.8 mm·Hg

(D) 0.62 atm

137. A quantity of gas at a temperature of 30°C doubles its pressure at a temperature of …

(A) 60°C

(B) 15°C

(C) 606°C

(D) 333°C

138. A mass of oxygen gas occupies a volume of 550 L at a temperature of 5°C and under a pressure of 1.013×10^5 N/m².

Its volume at a temperature of 30°C and under a pressure of 1.066×10^5 N/m² equals ……………

(A) 562.4 L

(B) 450.23 L

(C) 652.2 L

(D) 569.66 L

139. A quantity of gas has a pressure of 75 cm·Hg when its temperature was zero degrees Celsius. Calculate: its pressure at 91°C, knowing that its volume is constant.

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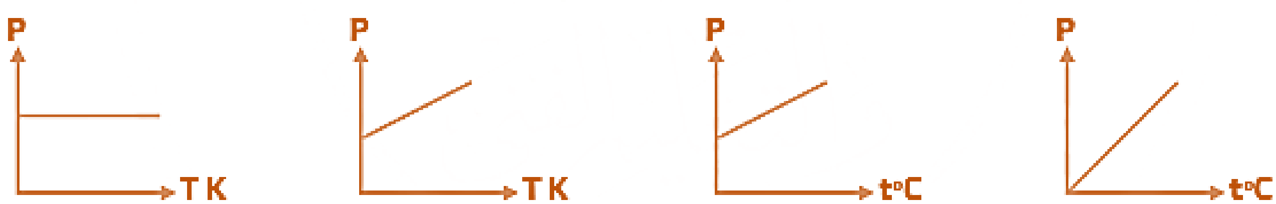
140. The correct graphical shape that represents the relationship between the pressure of a given quantity of gas and its temperature at constant volume is ……………



(A) (B) (C) (D)

141. A steel tank contains carbon dioxide at zero degrees Celsius under a pressure of 1.2×10^6 Pa. The value of the internal gas pressure when the gas is heated to 100°C equals ………..

(A) 2.3×10^6 Pa

(B) 1.6×10^5 Pa

(C) 1.6×10^4 Pa

(D) 1.64×10^6 Pa

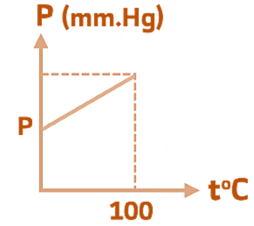
142. A quantity of gas at a temperature of 0°C in a tightly sealed container has its temperature raised by 100°C, causing its pressure to double. The coefficient of increase in pressure equals ……………

(A) 0.00366 K^{-1} (B) 273 K^{-1}

(C) 0.00268 K^{-1} (D) 373 K^{-1}

143. A uniform cross-section container contains a quantity of gas whose pressure is 5 atm at a temperature t°C.
If its temperature is increased by 10%, its pressure becomes ....
(A) 0.5 atm
(B) 4.45 atm
(C) 50 atm
(D) 5.5 atm

144. The opposite graph represents the relationship between the pressure of a quantity of gas and its temperature on the Celsius scale.
According to the graph, the gas pressure at 100°C equals ....
(A) 0.64 P
(B) 1.52 P
(C) 1.36 P
(D) 0.73 P



145. At standard pressure and temperature (STP.), it is ....
(A) Pressure = 1 atm, temperature = 0°C, and the molar volume of gas = 22.4 L
(B) Pressure = 76 cm·Hg, temperature = −273 K, and the molar volume of gas = 22.4×10^{-3} m³
(C) Pressure = 1 atm, temperature = −273 K, and the molar volume of gas = 22.4 L
(D) Pressure = 0.76 cm·Hg, temperature = 273 K, and the molar volume of gas = 22.4×10^{-3} m³

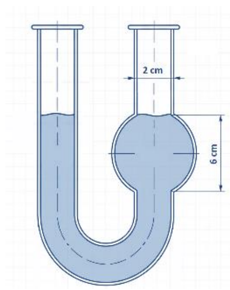
146. A thin-walled glass bulb has a temperature of 23°C. If the pressure of the gas inside it is 75 cm·Hg, find: the temperature to which the vessel can be heated without bursting, knowing that the maximum pressure its walls can withstand is 117 cm·Hg.

147. A butane gas cylinder is designed so that the maximum pressure it can withstand is 15 atm. If the gas pressure inside it at 50°C is 12 atm, then the minimum temperature that leads to its explosion is ....
(A) 131°C
(B) 130.75°C
(C) 404°C
(D) 403.75°C

148. 5 L of nitrogen gas at a temperature of 7°C and a pressure of 70 cm·Hg is mixed with 12 L of oxygen gas at a temperature of 27°C and a pressure of 80 cm·Hg.
The mixture is placed in a container of volume 20 L and temperature 127°C.
The pressure of the mixture equals ....
(A) 86 cm·Hg
(B) 75 cm·Hg
(C) 98.2 cm·Hg
(D) 89 cm·Hg

High Level

149. A U-shaped tube of diameter 2 cm has a spherical swelling (انتفاخ) in one of its branches. The swelling is spherical with a diameter of 6 cm. Initially, the U-tube is filled with water, such that the water level just reaches the top of the spherical swelling. Then oil of relative density 0.8 is slowly poured into the same branch that contains the swelling until the spherical swelling is completely filled with oil. Calculate the volume of oil poured.



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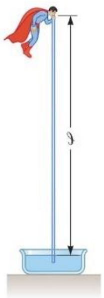
150. Superman is standing beside a container of water and tries to drink using a very long, rigid straw of length 12.0 m. The straw walls are extremely strong and do not collapse. By using his extraordinary ability, Superman removes all the air inside the straw, leaving no air at the top. Which of the following statements correctly describes what happens?



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151. TWO physical conditions which, if either occurs, make the liquid pressure at a point inside a liquid equal to zero.

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152. A U-shaped tube has arms with different cross-sectional areas and contains some water. Oil is poured continuously into the wider arm. What will be observed as the oil continues to be added?

(A) Water overflows from arm B, but oil does not overflow from arm A.
(B) Oil overflows from arm A, but water does not overflow from arm B.
(C) Water overflows from arm B and oil overflows from arm A at the same time.
(D) Water overflows from arm B, and afterward oil overflows from arm A.

153. A tangential force of 100 N acting on a small pistion of area 1 cm2 what will be the force resulting in the big piston of the hydraulic press whose area is 10 cm2

a) 100 N
b) 10 N
c) 1000 N
d) 0 N

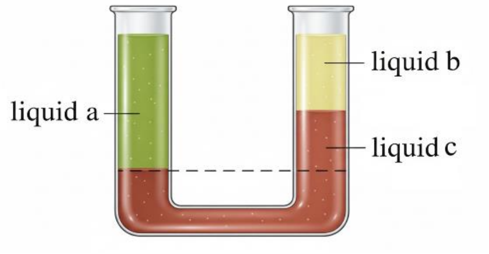
154. If the ratio of the radii of the pistons in a hydraulic press is 2/5, then the mechanical advantage of the press is:

a) 5/2
b) 25/4
c) 2/5
d) 4/25

155. If a system of 2 hydraulic presses is connected such that: the resulting force from a hydraulic press (A) is transmitted to be the input of the hydraulic press (B). what is the overall mechanical advantage of the system?

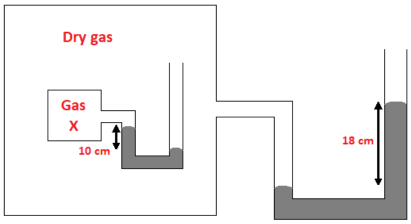
a) ηA + ηB b) ηA / ηB c) ηB – ηA d) ηA x ηB

156. The figure shows a U-shaped tube containing three immiscible liquids a, b, and c at equilibrium. The correct density order is ....



a) $\rho_a > \rho\ b > \rho\ c$
b) $\rho_a < \rho\ b > \rho\ c$
c) $\rho\ c > \rho_a > \rho\ b$
d) $\rho\ c > \rho\ b > \rho_a$

157. In the figure, a container contains a quantity of dry gas and is connected to a manometer. In the chamber there is another dry gas connected to another manometer as shown. Calculate the pressure inside container (X). (Pa=72 cm.Hg)



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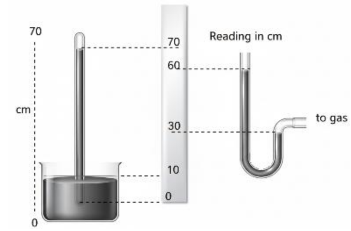
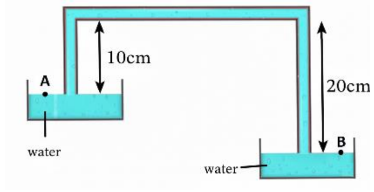
158. If a barometer and a manometer are placed in the same location as shown in the figure, then the pressure of the gas measured by the manometer is ……

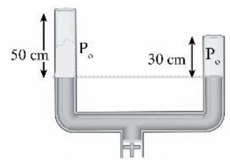


159. If the barometer reading is **H**, then the depth to which an inverted glass tube (open from the lower end) must be immersed in water until the volume of air inside it becomes **1/4** of its original volume is ……

160. In the shown figure, the pressure difference between points **A** and **B** is ……

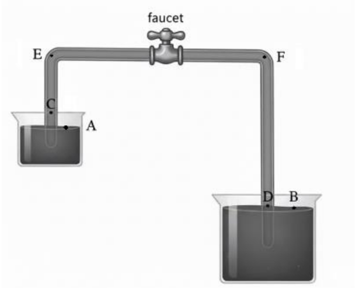


161. In the shown figure, two branches contain mercury, and the gas pressure in both branches is P_o. The cross-sectional area of each branch is **1 cm²**. If a quantity of mercury of **10 cm³** is added from below, such that the mercury rises **6 cm** in the left branch and **4 cm** in the right branch, calculate the value of P_o in both branches.



162. In the figure, two containers filled with water are connected by a water-filled tube and closed by a faucet. Points **A** and **C** are at the same level, and points **B** and **D** are also at the same level, with one inside the tube and the other on the water surface.

(a) Which is greater, the pressure at **E** or **F**, or are they equal?
(b) What happens when the faucet is opened? Explain.



163. A cylinder contains gas of mass **4 kg** and pressure **6 atm**. When the valve is opened, gas leaks out until the leakage process stops. The mass of the leaked gas becomes ……

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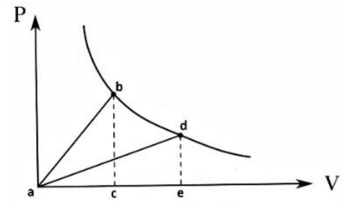
164. In the figure, the relationship between pressure and volume for a quantity of dry gas at constant temperature is shown. Prove that: the area of triangle **abc** equals the area of triangle **ade**.



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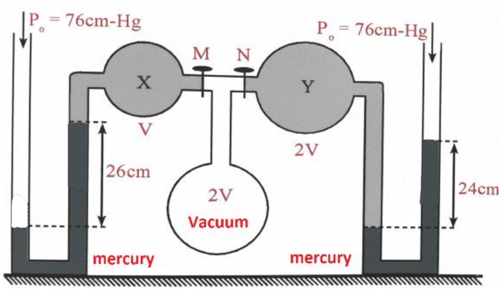
165. In the figure, when valves **N** and **M** are opened, the manometer reading equals ……… cmHg.



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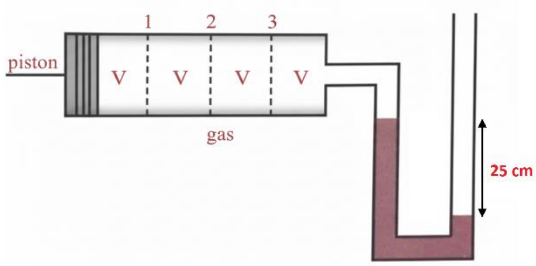
166. In the shown figure, a container of gas is connected to a mercury manometer, the atmospheric pressure is **70 cmHg**. If the piston is moved to position **(1)**, the manometer reading is $\mathbf{h_1}$, and when moved to position **(2)**, the reading is $\mathbf{h_2}$.
Find the value of $\mathbf{h_1 / h_2}$.



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