	INDIAN SCHOOL AL WADI AL KABIR	
Class: XI	**Department: SCIENCE 2025 – 26** **SUBJECT: PHYSICS**	**Date: 11/11/2025**
Worksheet No: 09 **WITH ANSWERS**	**CHAPTER / UNIT: MECHANICAL PROPERTIES OF FLUIDS**	**Note:** **A4 FILE FORMAT**
NAME OF THE STUDENT:	**CLASS & SEC:**	**ROLL NO.:**

OBJECTIVE TYPE OF QUESTIONS (1 MARK):

1) Which one of the following statements is correct for a fluid passing through the narrow part of a non-uniform pipe?
   a) its velocity decreases but its pressure increases
   b) its velocity and pressure both increase
   c) its velocity increases but its pressure decreases
   d) its velocity and pressure both decrease

2) Flow is said to be steady if
   a) the flow rate decreases 10% every second
   b) the flow rate does not change with time
   c) the flow rate increases with time
   d) the flow rate decreases 20% every second

3) The radius of one arm of a hydraulic lift is 3 times the radius of the other arm.What force should be applied at the narrow arm so as to lift 50 kg at the wider arm?
   a) 30 N
   b) 26.7 N
   c) 60 N
   d) 54.4 N

4) A particle falling through a viscous liquid reaches its terminal velocity. The acceleration then is
   a) g
   b) $< g$
   c) $>g$
   d) 0

5) The coefficient of viscosity for a fluid is defined as the ratio of
   a) shearing stress to the flow rate
   b) shearing stress to the strain rate
   c) compressive stress to the strain rate
   d) tensile stress to the strain rate

6) A block of density ρ floats in a liquid with its one third volume immersed. The density of the liquid is
   a) ρ
   b) $\rho/2$
   c) $\rho/3$
   d) 3ρ

7) If a film of width L is stretched in the longitudinal direction a distance d by force F, surface tension is given by
   a) F/2L
   b) F/4L
   c) F/L
   d) F/3L

8) In old age, arteries carrying blood in the human body became narrow resulting an increase in blood pressure. This follows from
   a) Pascal's law
   b) Bernoulli's principle
   c) Archimedes principle
   d) Stoke's law

9)When the adhesive force in the case of liquid and glass is greater than the cohesive forces between the liquid molecules, the shape of the meniscus of liquid in a capillary tube is?
   a) Plane
   b) Circular
   c) Concave
   d) Convex

10)The pressure at a point in water is 10 N/m^2. The depth below where the pressure becomes double is (Given density of water = 103 kg m^{-3}, g= 10 m^{-2})
   a) 1 mm
   b) 1 cm
   c) 1 m
   d) 10 cm

ASSERTION AND REASONING TYPE OF QUESTIONS (1 MARK):

DIRECTIONS: In the following questions, a statement of assertion (A) is followed by a statement of reason (R). Mark the correct choice as:

a) Both A and R are true, and R is the correct explanation of A.
b) Both A and R are true, and R is not the correct explanation of A.
c) A is true but R is false.
d) A is false but R is true

11**) Assertion:** At depth h below the water surface, pressure is p. Then at depth 2h pressure will be 2p (Ignore density variation).
Reason: With depth pressure increases linearly.

12)**Assertion**: Water does not wet wax
Reason: Angle of contact for water-wax is obtuse.

13)**Assertion:** Liquid does not overflow due to rise of liquid in a capillary tube of insufficient length.
Reason: Rise of liquid in a capillary tube is inversely proportional to the radius of area of cross-section of the tube.

14)**Assertion:** Ploughing a field reduces evaporation of water from the ground beneath.
Reason: Results in lowering of surface area open to sunlight

15)**Assertion:** In streamline flow, A × v is constant.
Reason: For incompressive flow, mass in = mass out

VERY SHORT ANSWER TYPE OF QUESTIONS: (2 MARK)

16) The blood pressure of humans is greater at the feet than at the brain. Why?

17)The velocity of water in a river is 18 kmh^{-1} near the surface. If the river is 5 m deep, find the shearing stress between horizontal layers of water. The coefficient of viscosity of water 10^{-2} poise.

18) Define surface tension.

19) Atmospheric pressure at a height of about 6 km decreases to nearly half of its value at the sea level, though the height of the atmosphere is more than 100 km. Why?

20) A body of mass 6 kg is floating in a liquid with 2/3 of its volume inside the liquid. Find ratio between the density of the body and density of liquid. Take g = $10m/s^2$.

SHORT ANSWER TYPE OF QUESTIONS (3 MARK):

21) A razor blade can be made to float on water. What forces act on the blade? Is Archimedes' principle applicable?

22)Derive expression for Torricelli's law.

OR

Derive expression for coefficient of viscosity.

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

24) The flow rate of water is 0.58 L/mm from a tap of diameter of 1.30 cm. After some time, the flow rate is increased to 4 L/min. Determine the nature of the flow for both the flow rates. The coefficient of viscosity of water is 10^{-3}Pa.s and the density of water is 103 kg/m^3.

25) If eight rain drops each radius 1 mm falling through air at a terminal velocity of 5 cm / s. If they coalesce to form a bigger drop, what is the terminal velocity of bigger drop?

LONG ANSWER TYPE OF QUESTIONS (5 MARK):

26) The surface tension of soap solution at 20 °C is N m^{-1}. Calculate the excess pressure inside a soap bubble of radius 5 mm of this solution. If an air bubble of the same dimension were formed at depth of

40.0 cm inside a container containing the soap solution of relative density 1.20, what would be the pressure inside the bubble? (1 atm = 1.01 *10^5 pa.).

27)Explain why?

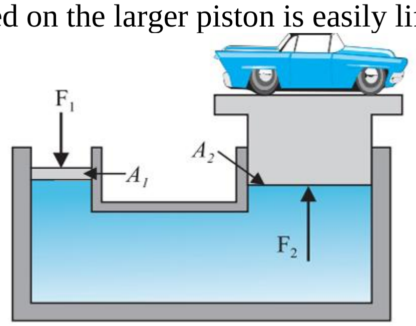
i. The size of the needle of a syringe controls flow rate better than the thumb pressure exerted by a doctor while administering an injection.
ii. Surface tension of a liquid is independent of the area of the surface.
iii. Water with detergents dissolved in it should have a small angle of contact.
iv. If a wet piece of wood burns, then water droplets appear on the other end.
v. The dams of the water reservoir are made thick near the bottom.

28) Two narrow bores of diameters 3.0 mm and 6.0 mm are joined together to form a U tube open at both ends. If the U-tube contains water, what is the difference in its levels in the two limbs of the tube? Surface tension of water at the temperature of the experiment is N m^{-1}. Take the angle of contact to be zero and density of water to be kg m^{-3} (g = 9.8 m s^{-2}).

29) State Stoke's law. Define terminal velocity and find an expression for the terminal velocity in case of a small sphere falling through a viscous liquid such as glycerin.

CASE STUDY TYPE OF QUESTIONS (4 MARK):

30)Hydraulic lift is an application of Pascal's law. It is used to lift heavy loads.It is a force multiplier. So, when small force is applied on the smaller piston (acting downward),it will be appearing as a very large force (acting upward) on the large piston. As a result of it, a heavy load placed on the larger piston is easily lifted upwards.



i. Pascal's law states that pressure in a fluid at rest is the same at all points, if
   a) they are at the same height
   b) they are along the same plane
   c) they are along the same line
   d) both a) and b)

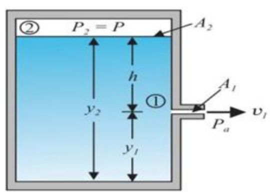
ii.Pressure is applied to an enclosed fluid as shown in the above figure. It is
   a) increased and applied to every part of the fluid.
   b) diminished and transmitted to the walls of the container.
   c) increased in proportion to the mass of the fluid and then transmitted.
   d) transmitted unchanged to every portion of the fluid and the walls of the container.

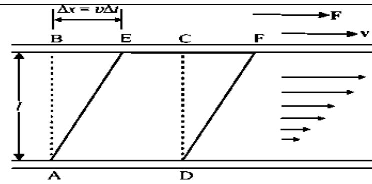
iii. Pressure at a point inside a liquid does not depend on
   a) the depth of the point below the surface of the liquid

b) the nature of the liquid
c) the acceleration due to gravity at that point
d) total weight of fluid in the beaker

iv. If work done by piston in the given figure on fluid is W_1, then work done by fluid in limbs on piston P_2 is
a) $W_1/4$
b) $4W_1$
c) $W_1/2$
d) W_1

ANSWER KEY	
1	c) its velocity increases but its pressure decreases
2	b) the flow rate does not change with time
3	d) 54.4 N
4	d) 0
5	b) shearing stress to the strain rate
6	d)3 ρ
7	a) F/2L
8	b) Bernoulli's principle
9	c) Concave
10	a)1 mm
11	a) Both A and R are true, and R is the correct explanation of A.
12	a) Both A and R are true, and R is the correct explanation of A.
13	b) Both A and R are true, and R is not the correct explanation of A.
14	c) A is true but R is false.
15	a) Both A and R are true, and R is the correct explanation of A.
16	The height of the blood column in the human body is more at the feet than at the brain. Since pressure is directly dependent on height of the column, so pressure is more at feet than at the brain.
17	As the velocity of water at the bottom of the river is zero, $dv = 18kmh^{-1} = 18 \times \frac{5}{18} = 5ms^{-1}$ Also, $dx = 5m$, η = 10^{-2} poise $= 10^{-3}Pa - s$ Force of viscosity, F = η.A.$\frac{dv}{dx}$ We know that, shearing stress = $\frac{F}{A}$ $\Rightarrow \frac{F}{A} = \eta\frac{dv}{dx} = \frac{10^{-3}\times 5}{5} = 10^{-3}NM^{-2}$
18	It is measured as the force acting on a unit length of a line imagined to be drawn tangentially anywhere on the free surface of the liquid at rest.
19	Density of air is maximum near the sea level. Density of air decreases with an increase in height from the surface. At a height of about 6 km, density decreases to nearly half of its value at the sea level. Atmospheric pressure is proportional to density. Hence, at a height of 6 km from the surface, it decreases to nearly half of its value at the sea level.

20	For a floating body, Buoyant force = Weight of liquid displaced Suppose V be the volume of the body $\frac{2}{3}V\rho_l g = \rho_b g$ where ρ_b = density of the floating body and ρ_l = density of the liquid $\frac{\rho_b}{\rho_l} = \frac{2}{3}$
21	When a razor blade can be made to float on water, three forces act on the blade: i. Weight of the blade acting vertically downwards. ii. Reaction on blade exerted by the liquid surface acting vertically upwards. iii. Force of the surface tension on circumference of the blade acting tangentially to the liquid surface. In this case, no portion of razor blade is immersed in water. Hence Archimedes principle is not applicable.
22	**Torricelli's law states that the speed of efflux of fluid through a small hole at a depth h of an open tank is equal to the speed of a freely falling body i.e, $\sqrt{2gh}$**  Consider a tank containing a liquid of density ρ with a small hole in its side at a height y_1 from the bottom. According to Bernoulli principle $P_1 + \frac{1}{2}\rho v_1^2 + \rho g h_1 = P_2 + \frac{1}{2}\rho v_2^2 + \rho g h_2$ Consider regions 1 and 2 According to equation of continuity ,since ($A_2 >> A_1$), $v_2 = 0$. $P_a + \frac{1}{2}\rho v_1^2 + \rho g y_1 = P + \rho g y_2$ $\frac{1}{2}\rho v_1^2 = \rho g(y_2 - y_1) + P - P_a$ $y_2 - y_1 = h$ $\frac{1}{2}\rho v_1^2 = \rho g h + P - P_a$ $v_1^2 = 2gh + \frac{2(P-P_a)}{\rho}$ $\mathbf{v_1 = \sqrt{2gh + \frac{2(P-P_a)}{\rho}}}$ If the tank is open to the atmosphere, then $P = P_a$ $\mathbf{v_1 = \sqrt{2gh}}$ This equation is known as Torricelli's law. This is the speed of a freely falling body.

	 **Due to viscous force, a portion of liquid, which at some instant has the shape ABCD, take the shape of AEFD after short interval of time (Δt).** **Shearing stress** $= \frac{F}{A}$ **Shearing strain** $= \frac{\Delta x}{l}$ **Strain rate**$= \frac{(\frac{\Delta x}{l})}{\Delta t} = \frac{\Delta x}{l\,\Delta t} = \frac{v}{l}$ **The coefficient of viscosity(η)for a fluid is defined as the ratio of shearing stress to the strain rate.** $\eta = \frac{\text{Shearing stress}}{\text{Strain rate}} = \frac{\frac{F}{A}}{\frac{v}{l}}$ $\eta = \frac{Fl}{vA}$ **The SI unit of coefficient viscosity is poiseiulle (Pl).** **Its other units are N s m^{-2} or Pa s.** **The dimensions are** $[ML^{-1}T^{-1}]$
23	The maximum allowable stress for the structure, $P = 10^9\text{Pa}$ Depth of the ocean, d = 3 km$= 3 \times 10^3\text{m}$ Density of water, $\rho = 10^3\text{kg/m}^3$ Acceleration due to gravity, $g = 9.8m/s^2$ The pressure exerted because of the sea water at depth, $d = \rho dg$ $= 3 \times 10^3 \times 10^3 \times 9.8$ $= 2.94 \times 10^7\text{Pa}$ The maximum allowable stress for the structure (109 Pa) is greater than the pressure of the sea water ($2.94 \times 10^7\text{Pa}$). The pressure exerted by the ocean is less than the pressure that the structure can withstand. Hence, the structure is suitable for putting up on top of an oil well in the ocean.
24	Given, diameter, $D = 1.30cm = 1.3 \times 10^{-2}m$ Coefficient of viscosity of water, $\eta = 10^{-3}Pa - s$ Density of water, $\rho = 10^3kg/m^3$ The volume of the water flowing out per second is $V = vA = v \times \pi r^2 = v\pi\frac{D^2}{4}$ Reynold's number, $R_e = \frac{\rho v D}{\eta} = \frac{4\rho v}{\eta\pi D}$ **Case I** When $V = 0.58L/min = \frac{0.58\times10^{-3}\text{m}^3}{1\times60\text{s}}$ $= 9.67 \times 10^{-6}m^3s^{-1}$ $R_e = \frac{4\times10^3\times9.67\times10^{-6}}{10^{-3}\times3.14\times1.3\times10^{-2}} = 948$ $\because R_e < 1000$, so the flow is steady or streamline **Case II** When $V = 4L/min$ $= \frac{4\times10^{-3}}{60}\ m^3s^{-1} = 6.67\times10^{-5}m^3s^{-1}$ $R_e = \frac{4\times10^3\times6.67\times10^{-5}}{10^{-3}\times3.14\times1.3\times10^{-2}} = 6536$ $\because R_e > 3000$, so the flow will be turbulent.

25	Let the radius of smaller drop = r Let the radius of bigger drop = R Volume of smaller drop $= \frac{4}{3}\pi r^3$ Volume of bigger drop $= \frac{4}{3}\pi R^3$ Now, according to the question, Volume of bigger drop = Volume of 8 smaller drops. $\frac{4}{3}\pi R^3 = 8 \times \frac{4}{3}\pi r^3$ $R^3 = 8r^3$ Taking cube – root R = 2r = 2 $\times$ 1 mm (r = 1mm (Given)) = 2mm = 0.2 cm (1 cm = 10 mm) Now, Terminal velocity of each small drop $N_T = \frac{2}{9} \times \frac{r^2}{\eta}(P - \sigma)g \rightarrow 1)$ Terminal velocity of bigger drop $V_T = \frac{2}{9} \times \frac{R^2}{\eta}(P - \sigma)g \rightarrow 2)$ η = Co-efficient of viscosity P = Density of body σ = Density of fluid g = acceleration due to gravity Dividing eq^4 2) by 1) $\frac{V_T}{N_T} = \frac{R^2}{r^2}$ $V_T = N_T \times \frac{R^2}{r^2}$ Given Terminal velocity of small drop = 5 cm/s $V_T = 5 \times \frac{(0.2)^2}{(0.1)^2}$ $= 5 \times \frac{0.04}{0.01}$ V_T = 20 cm/s
26	Calculation of excess pressure inside soap bubble It is given that the radius of the bubble, r = 5.00 mm = 5×10^{-3} m and Surface tension of the soap solution, S = 2.50×10^{-2} N m^{-1} according to the question the relative density of the soap solution is = 1.20 $\therefore$ Density of the soap solution, $\rho = 1.2 \times 10^3\ \mathrm{kg/m^3}$ depth at which air bubble is formed , h = 40 cm = 0.4 m Radius of the air bubble, r = 5 mm = $5 \times 10^{-3} m$ The excess pressure inside the soap bubble is given by the relation: $P = \frac{4S}{r}$, where S is surface tension and r is radius of the bubble $= \frac{4 \times 2.5 \times 10^{-2}}{5 \times 10^{-3}}$ = 20 Pa Therefore, the excess pressure inside the soap bubble is 20 Pa. calculation of execess pressure inside an air bubble The excess pressure inside the air bubble is given by the relation: $P' = \frac{2S}{r}$, where S is surface tension and r is radius of the bubble $= \frac{2 \times 2.5 \times 10^{-2}}{5 \times 10^{-3}}$ = 10 Pa Therefore, the excess pressure inside the air bubble is 10 Pa. At a depth of 0.4 m, the total pressure inside the air bubble $P_{total} = P_{atm} + h\rho g + P'$ $= 1.01 \times 10^5 + 0.4 \times 1.2 \times 10^3 \times 9.8 + 10$ $= 1.057 \times 10^5$ Pa $= 1.06 \times 10^5$ Pa Therefore, the pressure inside the air bubble is 1.06×10^5 Pa

27	i. The small opening of a syringe needle controls the velocity of the blood flowing out. This is because of the equation of continuity. At the constriction point of the syringe system, flow rate suddenly increases to a high value for a constant thumb pressure applied. ii. Surface tension of liquid is the force acting per unit length on a line drawn tangentially to the liquid. Since this force is independent of the area of liquid surface; therefore, surface tension is also independent of the area of the liquid surface. iii. We know clothes have narrow spaces in the form of capillaries. The rise of liquid in a capillary tube is directly proportional to cos θ. If θ is small cos θ will be large. Due to which capillary rise will be more and so the detergent will penetrate more in clothes. iv. The wet piece of wood contains quite a bit of moisture. The moisture is converted into steam and travels through the wood piece to the end of the piece. Since the end of the piece is cool the steam or water vapor turns back into water and due to surface tension, they appear in form of water drops on the other end. v. The pressure "P" exerted by liquid column at a depth "h" below the top surface of that liquid P= h ρ g. Where is the density of fluid. So as depth 'h' increases, P will also increase. So, to withstand high-pressure dams are made thick near the bottom.
28	Diameter of the first bore, $d_1 = 3.0\mathrm{mm} = 3 \times 10^{-3}\mathrm{m}$ thus, the radius of the first bore, $r_1 = \frac{d_1}{2} = 1.5 \times 10^{-3} m$ Diameter of the second bore, $d_2 = 6.0\mathrm{mm} = 6.0 \times 10^{-3}\mathrm{m}$ Hence, the radius of the second bore, $r_2 = \frac{d_2}{2} = 3.0 \times 10^{-3}\mathrm{m}$ Surface tension of water, $S = 7.3 \times 10^{-2} Nm - 1$ Angle of contact between the bore surface and water, $\theta = 0$ Density of water, $\rho = 10^3 \mathrm{kg/m^3}$ Acceleration due to gravity, f = 9.8 m/s2 Let h_1 and h_2 be the heights to which water rises in the first and second tubes respectively. These heights are given by the relations: $h_1 = \frac{2s\cos\theta}{r_1 \rho g}$ ...(i) $h_2 = \frac{2s\cos\theta}{r_2 \rho g}$ ....(ii) The difference between the levels of water in the two limbs of the tube can be calculated as: $\Delta h = \frac{2s\cos\theta}{r_1 \rho g} - \frac{2s\cos\theta}{r_2 \rho g}$ $\Delta h = \frac{2s\cos\theta}{\rho g}\left[\frac{1}{r_1} - \frac{1}{r_2}\right]$ $\Delta h = \frac{2\times 7.3\times 10^{-2}\times 1}{1\times 10^3\times 9.8}\left[\frac{1}{1.5\times 10^{-3}} - \frac{1}{3\times 10^{-3}}\right]$ $\Delta h = 4.966 \times 10^{-3}\mathrm{m}$ Δh = 4.97 mm Hence, the difference between levels of water in the two bores is 4.97 mm.
29	According to stokes' law for steady flow law, the backward dragging force acting on a small spherical body of radius r moving with a velocity v through a viscous medium of the coefficient of viscosity η is given by $F = 6\pi\eta r v$ When a spherical body of small size falls freely through a viscous fluid, the relative

	motion produce a viscous drag which opposes the motion of the freely falling body. In accordance with Stokes' formula for viscous force (F = $6\pi\eta rv$), the magnitude of viscous force increases with an increase in the speed of the falling body.Consequently, the body starts falling with a constant velocity without any acceleration. this constant velocity with which a body falls through a viscous fluid is called the terminal velocity of that body. Consider a small sized spherical body of radius r moving downward through a viscous fluid of viscosity η. Let densities of solid and the fluid be ρ and σ respectively. The forces acting on the body are: i. Weight of the body acting downward $W - mg = \frac{4}{3}\pi r^3 \rho g$ ii. Upthrust due to displaced fluid acting vertically upward $u = \frac{4}{3}\pi r^3 \sigma g$ iii. Viscous force due to Stokes' law acting upward $F = 6\pi\eta rv$ In equilibrium when there is no acceleration and body falls with a constant velocity v_T, the terminal velocity, $\Rightarrow W - U - F = 0$ or $F = W - U$ $\therefore 6\pi\eta r v_T = \frac{4}{3}\pi^3 \rho g - \frac{4}{3}\pi^3 \sigma g = \frac{4}{3}\pi r^3(\rho - \sigma)g$ $\Rightarrow$ Terminal velocity $v_T = \frac{2}{9}\frac{r^2}{\eta}(\rho - \sigma)g$
30	i. a) They are at the same height ii. d) Transmitted unchanged to every portion of the fluid and the walls of the container. iii. d) Total weight of fluid in the beaker iv. d) W_1

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