OPSC 2019

Odisha Public Service Commission

Civil Engineering

Objective Practice Sets

Fluid Mechanics

Contents

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1 CHAPTER
Fluid Properties

Q.1 Match **List-I** (Fluid) with **List-II** (Classification of fluid) and select the correct answer using the codes given below the lists:

List-I

A. Gasoline
B. Suspended starch solution
C. Tooth paste
D. Blood

List-II

1. Shear thickening fluid
2. Shear thinning fluid
3. Bingham plastic fluid
4. Newtonian fluid
5. Thixotropic fluid

Codes:

	A	B	C	D
(a)	4	2	5	1
(b)	4	1	3	2
(c)	4	3	1	2
(d)	3	4	1	5

Q.2 Work done in blowing a soap bubble of diameter 12 cm will be [Assume surface tension of soap solution as 0.04 N/m]

(a) 18.09×10^{-4} N-m
(b) 9.05×10^{-4} N-m
(c) 7.24×10^{-3} N-m
(d) 36.2×10^{-4} N-m

Q.3 The dimensions of dynamic viscosity (μ) are

(a) $ML^{-1}T^{-2}$ (b) $ML^{-1}T^{-1}$
(c) MLT^{-2} (d) $M^0L^0T^0$

Q.4 The liquid used in manometers should have

(a) low density
(b) high density
(c) low surface tension
(d) high surface tension

Q.5 A circular disc of diameter 'd' is slowly rotated in a liquid of large viscosity μ at a small distance h from a fixed surface. The minimum torque required to maintain an angular velocity ω will be

(a) $\frac{\mu\pi d^4\omega}{32h}$ (b) $\frac{\mu\pi d^4\omega}{8h}$

(c) $\frac{\mu\pi d^3\omega}{32h}$ (d) $\frac{\mu\pi d^3\omega}{8h}$

Q.6 What is the capillary rise in a narrow two-dimensional slit of width 'w'?

(a) Half of that in a capillary tube of diameter 'w'
(b) Two-third of that in a capillary tube of diameter 'w'
(c) One-third of that in a capillary tube of diameter 'w'
(d) One-fourth of that in a capillary tube of diameter 'w'

Q.7 Consider the following statements:

1. A small bubble of one fluid immersed in another fluid has a spherical shape.
2. The droplets of a fluid move upward or downward in another fluid due to unbalance between gravitational and buoyant forces.
3. Droplets of bubbles attached to a solid surface can remain stationary in a gravitational fluid if the surface tension exceeds buoyant forces.
4. Surface tension of a bubble is proportional to its radius while buoyant force is proportional to the cube of its radius

Which of these statements are correct?
(a) 1, 2, 3 and 4 (b) 1, 2 and 4
(c) 1 and 3 only (d) 2, 3 and 4

Q.8 A fluid (sp. gr. = 0.9, μ = 1.2 Pas) flows in a laminar state between two stationary parallel plates set 3 cm apart. If the steady discharge is 600 cm^3/s per cm width of plates, the shear stress at a distance 1 cm from either boundary is
(a) 160 Pa (b) 320 Pa
(c) 480 Pa (d) 640 Pa

Q.9 An increase in pressure of 2 bars decreases the volume of a liquid by 0.01%. The bulk modulus of elasticity of liquid is
(a) 2×10^5 N/m^2 (b) 2×10^7 N/m^2
(c) 2×10^9 N/m^2 (d) 2×10^{11} N/m^2

Q.10 Which of the following statement is correct?
(a) Dynamic viscosity of water is nearly 50 times to that of air
(b) Kinematic viscosity of water is 30 times more that of air
(c) Water is soil is able to rise a considerable distance above the groundwater table due to viscosity
(d) Vapour pressure of a liquid is inversely proportional to the temperature.

Q.11 Which one of the following pressure unit represents the least pressure?
(a) millibar (b) mm of Hg
(c) N/mm^2 (d) kgf/cm^2

Q.12 **Assertion (A):** At the standard temperature, the kinematic viscosity of air is greater than that of water at the same temperature.
Reason (R): The dynamic viscosity of air at standard temperature is lower than that of water at the same temperature.
(a) both A and R are true and R is the correct explanation of A
(b) both A and R are true but R is not a correct explanation of A
(c) A is true but R is false
(d) A is false but R is true

Q.13 Match **List-I** with **List-II** and select the correct answer using the codes given below the lists:

List-I
A. Lubrication
B. Rise of sap in trees
C. Formation of droplets
D. Cavitation

List-II
1. Capillary
2. Vapour pressure
3. Viscosity
4. Surface tension

Codes:

	A	B	C	D
(a)	2	4	1	3
(b)	3	4	1	2
(c)	2	1	4	3
(d)	3	1	4	2

Q.14 Force necessary to lift a thin platinum wire ring of 3 cm diameter from a water surface will be [neglect the weight of wire]
(a) 0.0137 N (b) 0.0275 N
(c) 0.0069 N (d) 0.0034 N

Q.15 **Assertion (A):** Cavitation occurs when the velocity is high and pressure is low.
Reason (R): Vapour cavitation is less damaging than air cavitation.
(a) both A and R are true and R is the correct explanation of A
(b) both A and R are true but R is not a correct explanation of A
(c) A is true but R is false
(d) A is false but R is true

■■■■

Answers Fluid Properties

1. (b)	2. (d)	3. (b)	4. (a)	5. (a)	6. (a)	7. (a)	8. (a)	9. (c)	10. (a)
11. (a)	12. (b)	13. (d)	14. (a)	15. (c)					

Explanations Fluid Properties

2. (d)

The soap bubble has two interfaces

$\therefore$ Workdone $= 0.04 \times 4\pi \times (6 \times 10^{-2})^2 \times 2$

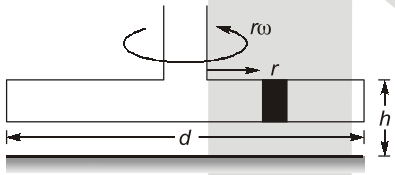
$= 36.2 \times 10^{-4}$ N-m

4. (a)

The liquid used in manometer should be of light density so as to measure even small variation in pressure.

5. (a)

Consider an element of disc at a distance r and having width dr linear velocity at this radius $r\omega$



$$\text{Shear stress} = \mu\frac{dv}{dy}$$

Torque = Shear stress × area × r

$$= \tau \times 2\pi r dr \times r = \mu\frac{du}{dy}2\pi r^2 dr$$

Assuming that gap h is small so that velocity distribution may be assumed linear

$$\therefore \quad \frac{du}{dy} = \frac{r\omega}{h}$$

$$dT = \mu\frac{r\omega}{h}2\pi r^2 dr$$

$$\therefore \quad T = \int^{d/2}\frac{2\pi\mu\omega}{h}r^2 dr = \frac{\mu\pi d^4\omega}{32h}$$

8. (a)

For small gap, τ is assumed to be constant

$$v_{avg} = \frac{Q}{y} = \frac{600}{3} = 200 \text{ cm/sec}$$

$$\therefore \quad \frac{dv}{dy} = \frac{200}{1.5}$$

$$\therefore \quad \tau = \mu\frac{dv}{dy} = 1.2 \times \frac{200}{1.5} = 160 \text{ Pa}$$

9. (c)

dp = Increase in pressure = 2 bars

dV = Decreases in volume = 0.01%

$$\therefore \quad -\frac{dV}{V} = \frac{0.01}{100}$$

Bulk modulus, K is given by

$$K = \frac{dp}{-\frac{dV}{V}} = \frac{2}{\frac{0.01}{100}} = 2 \times 10^4 \text{ bars}$$

Now, 1 bar $= 10^5$ N/m^2

$\therefore \quad K = 2 \times 10^4 \times 10^5$ N/m^2

$= 2 \times 10^9$ N/m^2

10. (a)

Water is about 50 times viscous than air. Kinematic viscosity of air is more than that of water.

11. (a)

1 millibar < 1 mm Hg < 1 kgf/cm^2 < 1 N/mm^2

14. (a)

$\sigma = 0.073$ N/m

Considering length

= 2 × Circumference of ring

$\therefore$ Force $= \sigma \times l$

$= 0.073 \times 2 \times \pi \times d$

$= 0.073 \times 2 \times 3.14 \times 0.03$

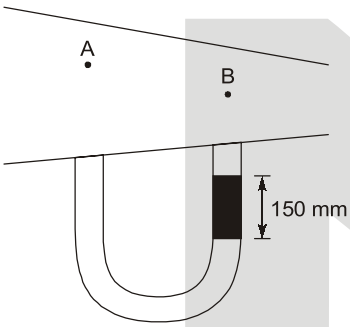
$= 0.0137$ N

15. (c)

A is true but R is false.

2 CHAPTER
Fluid Pressure and its Measurement

Q.1 A U-tube manometer with a small quantity of mercury is used to measure the static pressure difference between two locations *A* and *B* in a conical section through which an incompressible fluid flows. At a particular flow rate, the mercury column appears as shown in the figure. (ρ_{Hg} = 13600 kg/m^3, g = 9.81 m/s^2). Which of the following is correct?



(a) Flow direction is from *A* to *B* and $p_A - p_B$ = 20 kPa
(b) Flow direction is from *B* to *A* and $p_A - p_B$ = 1.4 kPa
(c) Flow direction is from *A* to *B* and $p_B - p_A$ = 20 kPa
(d) Flow direction is from *B* to *A* and $p_B - p_A$ = 1.4 kPa

Q.2 The lower portion of a U-tube of uniform bore having both limbs vertical and open to atmosphere, is initially filled with a liquid of specific gravity 3*S*. A lighter liquid of specific gravity *S* is then poured into one of the limbs such that the length of column of lighter liquid is X. What is the resulting movement of the meniscus of the heavier liquid in the other limb?

(a) X (b) X/2
(c) X/3 (d) X/6

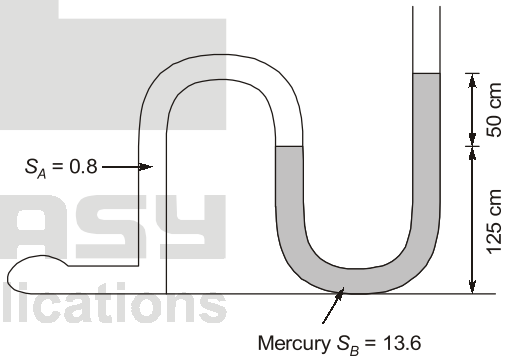
Q.3 How is the difference of pressure head '*h*' measured by a mercury oil differential manometer expressed?

(a) $h = X\left(1 - \frac{s_g}{s_o}\right)$ (b) $h = X\left(s_g - s_o\right)$

(c) $h = X\left(s_o - s_g\right)$ (d) $h = X\left(\frac{s_g}{s_o} - 1\right)$

While X = manometer reading; s_g and s_o are the specific gravities of mercury and oil, respectively.

Q.4 What is the absolute pressure at *A* measured by an open tube manometer as in the figure below? (Assume atmospheric pressure as 103 kN/m^2; s_A and s_B are the specific gravities of the two fluid)



(a) 78.5 kN/m^2 (b) 180 kN/m^2
(c) 1030 kN/m^2 (d) 103 kN/m^2

Q.5 In a quiescent sea, density of water at free surface is ρ_o and at a point much below the surface density is ρ. Neglecting variation in gravitational acceleration g and assuming a constant value of bulk modulus k, the depth '*h*' of the point from free surface is

(a) $\frac{k}{g}\left(\frac{1}{\rho_o}+\frac{1}{\rho}\right)$ (b) $\frac{k}{g}\frac{(\rho-\rho_o)}{(\rho+\rho_o)^2}$

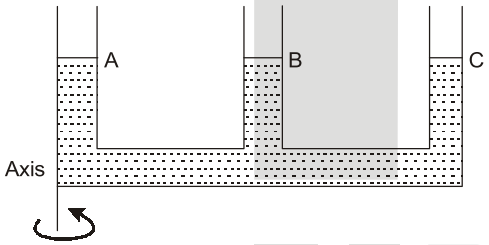
(c) $\frac{k}{g}\left(\frac{1}{\rho_o}-\frac{1}{\rho}\right)$ (d) $\frac{k}{g}\left(\frac{\rho\rho_o}{\rho+\rho_o}\right)$

Q.6 **Assertion (A):** The important property for a liquid to use it as manometric fluid is its colour for visibility.

Reason (R): Inclined manometers are used to measure low pressures.

(a) both A and R are true and R is the correct explanation of A
(b) both A and R are true but R is not a correct explanation of A
(c) A is true but R is false
(d) A is false but R is true

Q.7 A multi-tube manometer filled with water up to level *A*, *B* and *C* as shown in figure is rotated about the vertical axis at *A*.



The water levels at *A*, *B* and *C* will all be on

(a) a circle (b) an ellipse
(c) a hyperbola (d) a parabola

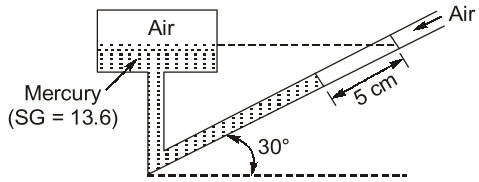
Q.8 A U-tube open at both ends made of 8 mm diameter glass tube has mercury in the bottom to a height of 10 cm above the horizontal limb. If 19 cc of water is added to one of the limbs, the difference in mercury levels at equilibrium is

(a) 3.0 cm (b) 2.8 cm
(c) 1.0 cm (d) zero

Q.9 A vertical U-tube with two legs 2 m apart is filled with water and rotated about a vertical axis 0.5 m from one leg. The difference in elevation of water levels in the two legs, open to atmosphere, when the speed of rotation is 45 rpm is, nearly.

(a) 0.283 m (b) 2.263 m
(c) 2.546 m (d) 2.83 m

Q.10 The gauge pressure at point '*A*' in the inclined manometer shown in the given figure is:



(a) 6680 N/m^2
(b) –6680 Nm^2
(c) 3340 N/m^2
(d) –3340 N/m^2

Q.11 The pressure intensity is same in all directions at a point

(a) only when fluid is frictionless and incompressible
(b) only when fluid is frictionless and is at rest
(c) only when fluid is frictionless
(d) when there is no relative motion of one fluid layer relative to other

Q.12 Consider the following statements:

1. In a fluid under motion, the pressure at a point is always perpendicular to the surface.
2. Pascal's law states that the pressure at a point is same in all directions.
3. Magnitude of pressure of a fluid at a point is obtained from hydrostatic law.
4. Pascal's law is applicable in the operation of a hydraulic press.

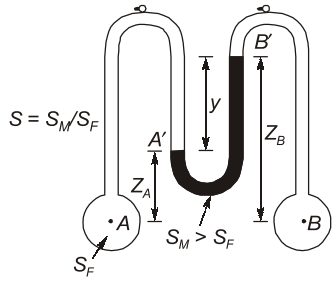
Which of these statements are correct?

(a) 1, 2 and 3 (b) 1, 3 and 4
(c) 1, 2 and 4 (d) 2, 3 and 4

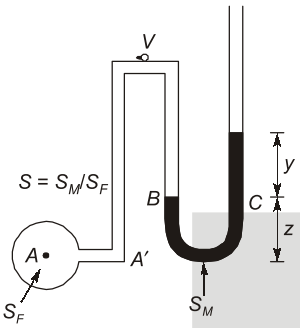
Q.13 Which of the following is correct regarding piezometer

(a) High pressure can not be measured
(b) Negative pressure can not be measured
(c) Gas pressure can not be measured
(d) All of the above

3.



4.



Codes:

	A	B	C	D
(a)	3	4	1	2
(b)	1	2	3	4
(c)	3	2	1	4
(d)	1	4	3	2

Q.20 A pressure gauge reads 57.4 kPa and 80 kPa respectively at heights of 8 m and 5 m fitted on the side of a tank filled with liquid. What is the approx. density of the liquid in kg/m^3?

(a) 393
(b) 768
(c) 1179
(d) 7530

■■■■

Answers Fluid Pressure and its Measurement

1. (a)	2. (d)	3. (d)	4. (b)	5. (c)	6. (d)	7. (d)	8. (b)	9. (b)	10. (d)
11. (d)	12. (d)	13. (d)	14. (b)	15. (a)	16. (a)	17. (c)	18. (c)	19. (b)	20. (b)

Explanations Fluid Pressure and its Measurement

1. (a)

$$p_A - p_B = \rho_g \Delta h$$

$$= 13.6 \times 1000 \times 9.81 \times \left(\frac{150}{1000}\right) = 20 \text{ kPa}$$

2. (d)

$$(S) \times (X) = (3S) \times (y)$$

$$y = X/3$$

$\therefore$ Resulting movement of meniscus = $x/6$

4. (b)

$$P_A - (\rho_A g h_A) - (\rho_m g h_m) - P_a = 0$$

$$P_A - (0.8 \times 10^3 + 9.812 \times 1.25) - (13.6 \times 10^3 \times 9.812 \times 0.5) - 103 \times 10^3 = 0$$

$\Rightarrow P_A = 179.53$ kPa

6. (d)

The important property for a liquid to use it as manometric fluids is its high density and low vapour pressure.

Inclined manometers are more sensitive than vertical manometers, hence they are used for low pressures.

8. (b)

$$\frac{19}{\frac{\pi}{4} \times (0.8)^2} \times \gamma_w + \left(10 - \frac{h}{2}\right) \times 13.6 \gamma_w$$

$$= \left(10 + \frac{h}{2}\right) 13.60\ \gamma_w$$

$\Rightarrow h = 2.8$ cm