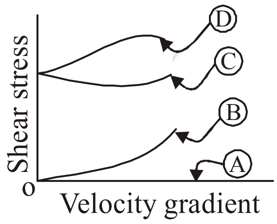
QUESTION BANK

1. Match List-I (Curves labelled A, B, C and D in figure) with List-II (Type of fluid) and select the correct answer using the codes given below the lists:

List-I



List-II

1. Ideal plastic
2. Ideal
3. Non-Newtonian
4. Rheopectic
5. Thixotropic

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

2. If bulk modulus of water is 2×10^8 kgf/cm^2 (19.62×10^8 N/m^2), then water hammer wave celerity through a rigid pipe line will be
(a) 600 m/s
(b) 800 m/s
(c) 1200 m/s
(d) 1400 m/s

3. Surface tension is due to
(a) Cohesion and adhesion
(b) cohesion only
(c) Adhesion only
(d) None of the above

4. Continuum approach in fluid mechanics is valid when
(a) The compressibility is very high
(b) The viscosity is low
(c) The mean free path of the molecule is much smaller compared to the characteristic dimension
(d) M >> 1, where M is the Mach number

5. A fluid is said to be Newtonian fluid when the shear stress is
(a) directly proportional to the velocity gradient
(b) inversely proportional to the velocity gradient
(c) independent of the velocity gradient
(d) none of the above

6. A fluid is one which can be defined as a substance that:
(a) has same shear stress at all points
(b) can deform indefinitely under the action of the smallest shear force
(c) has the small shear stress in all directions
(d) is practically incompressible

7. The dimension of surface tension is:
(a) ML^{-1} (b) L^2V^{-1}
(c) $ML^{-1}\,T^{-1}$ (d) MT^{-2}

8. A dimensionless combination of pressure drop ΔP, dynamic viscosity μ, velocity V and length L is
(a) $\frac{\Delta P}{V^2.L}$ (b) $\frac{VL}{\mu}$
(c) $\frac{\Delta P}{\mu.VL}$ (d) $\frac{\Delta P.L}{\mu.V}$

9. Shear stress in the Newtonian fluid is proportional to
(a) pressure
(b) strain
(c) strain rate
(d) the inverse of the viscosity

10. A liquid of density ρ and dynamic viscosity μ flows steadily down an inclined plane in a thin sheet of constant thickness t. Neglecting air friction the shear stress on the bottom surface due to the liquid flow is (where θ is the angle, the plane makes with horizontal).
(a) $\rho g t \sin\theta$ (b) $\rho g t \cos\theta$
(c) $\mu\sqrt{g/t}$ (d) ρg.

11. With increase of temperature, viscosity of a fluid

(a) Does not change

(b) Always increases

(c) Always decreases

(d) Increases, if the fluid is a gas and decreases, if it is a liquid

12. The unit of dynamic viscosity of a fluid is

(a) m^2/s (b) $\frac{N \cdot s}{m^2}$

(b) $\frac{Pa \cdot s}{m^2}$ (d) $\frac{kg \cdot s^2}{m^2}$

13. The unit of surface tension is:

(a) N/m^2 (b) J/m

(c) J/m^2 (d) W/m

14. If 'P' is the gauge pressure within a spherical droplet, then gauge pressure within a bubble of the same fluid and of same size will be:

(a) $\frac{P}{4}$ (b) $\frac{P}{2}$

(c) P (d) 2P

15. Kinematic viscosity of air at 20° C is given to be 1.6×10^{-5} m^2/s. Its kinematic viscosity at 70° C will be varying approximately:

(a) 2.2×10^{-5} m^2/s (b) 1.6×10^{-5} m^2/s

(c) 1.2×10^{-5} m^2/s (d) 3.2×10^{-5} m^2/s

16. Match List-I (Fluid properties) with List-II (Related terms) and select the correct answer using the codes given below the lists:

List-I	List-II
A. Capillarity	**1.** Cavitation
B. Vapour pressure	**2.** Density of water
C. Viscosity	**3.** Shear forces
D. Specific gravity	**4.** Surface tension

Codes:

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

17. Which one of the following is the bulk modulus K of a fluid? (Symbols have the usual meaning)

(a) $\rho\frac{dp}{d\rho}$ (b) $\frac{dp}{\rho d\rho}$

(c) $\rho\frac{d\rho}{dp}$ (d) $\frac{d\rho}{\rho dp}$

18. Which of the following forces act on a fluid at rest?

1. Gravity force

2. Hydrostatic force

3. Surface tension

4. Viscous force

Select the correct answer using the codes given below:

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

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

19. Surface tension is due to

(a) viscous forces

(b) cohesion

(c) adhesion

(d) the difference between adhesive and cohesive forces

20. Newton's law of viscosity depends upon the

(a) stress and strain in a fluid

(b) shear stress, pressure and velocity

(c) shear stress and rate of strain

(d) viscosity and shear stress

21. If the surface tension of water-air interface is 0.073 N/m, the gauge pressure inside a rain drop of 1 mm diameter will be

(a) 0.146 N/m^2

(b) 73 N/m^2

(c) 146 N/m^2

(d) 292 N/m^2

22. A fluid compressed in a cylinder has a volume of 0.011 32 m^3 at a pressure of 70.30 kg(f)/cm^2. What should be the new pressure in order to make its volume 0.011 21 m^3 ? Assume bulk modulus of elasticity *K* of the liquid as 7034 kgf/cm^2.

(a) $140.2\frac{kgf}{cm^2}$ (b) $138.61\frac{kgf}{cm^2}$

(c) $150.1\frac{kgf}{cm^2}$ (d) $161\frac{kgf}{cm^2}$

23. A cylinder 0.1 m diameter rotates in an annular sleeve 0.102 m internal diameter at 100 r.p.m. The cylinder is 0.2 m long. If the dynamic viscosity of the lubricant between the two cylinders is 1.0 poise, find the torque needed to drive the cylinder against viscous resistance. Assume that Newton's Law of viscosity is applicable and the velocity profile is linear.

(a) 0.1645 N.m (b) 0.1645 kN.m

(c) 0.213 N.m (d) 0.213 kN.m

24. If the volume of a liquid decreases by 0.2 percent for an increase of pressure from 6.867 MN/ m^2 to 15.696 MN/m^2, what is the value of the bulk modulus of the liquid ?

(a) 4418 MPa (b) 441.8 MPa

(c) 4.418 MPa (d) 44180. MPa

25. If a certain liquid has a viscosity of 0.048 poise and kinematic viscosity 3.50 x 10^{-2} stokes, what is its specific gravity?

(a) 1.23142 (b) 1.001

(c) 1.37142 (d) 1.17353

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ANSWERS AND EXPLANATIONS

1. ***Ans. (a)***

Horizontal line representing zero shear stress for any velocity gradient is the condition for ideal fluid.

The curve B represents dilatant fluid.

$$\boxed{\tau = \mu\left(\frac{du}{dy}\right)^n \; n > 1}$$

For pseudoplastic fluid, $\boxed{\tau = \mu\left(\frac{du}{dy}\right)^n \; n < 1}$

For thixotropic fluid, $\boxed{\tau = \tau_0 + \mu\left(\frac{du}{dy}\right)^n \; n < 1}$

For rheopectic fluid, $\boxed{\tau = \tau_0 + \mu\left(\frac{du}{dy}\right)^n \; n > 1}$

For plastic fluid, $\boxed{\tau = \tau_0 + \mu\left(\frac{du}{dy}\right) \text{i.e., } n = 1}$

2. ***Ans. (d)***

$$C = \sqrt{\frac{k}{\rho}} = \sqrt{\frac{19.62 \text{ x } 10^8}{1000}} = 1400 \text{ m/s}$$

K = bulk modulus of elasticity

ρ = mass density of water

3. ***Ans. (b)***

Surface tension is due to cohesive force only.

4. ***Ans. (c)***

Continuum approach means properties uniform through out the medium. This condition is valid only when mean free path (λ) is much lower as compare to characteristic length (L_C).

5. ***Ans. (a)***

For newtonian fluid

$$\boxed{\tau \alpha \frac{du}{dy} \alpha \frac{d\theta}{dt}}$$

6. ***Ans. (b)***

Fluid is substance which deform continuously under the action of small shear or tangential force.

7. ***Ans. (d)***

Surface tension = $\frac{F}{\ell}$

$$\boxed{= \left(\frac{N}{m}\right) = \frac{kg \cdot m/s^2}{m} = [M^1L^0T^{-2}]}$$

8. ***Ans. (d)***

$$\Delta P = N/m^2 = kg.\frac{m}{sec^2}/m^2 = M^1.L^{-1}.T^{-2}$$

$$V = m/s = L^1T^{-1}$$

$$L = M = L^1$$

$$\mu = \frac{N-S}{m^2} = kg/m-s = M^1.L^{-1}T^{-1}$$

$$\mu = \frac{N-S}{m^2} = kg/m-s = m^1.L^{-1}T^{-1}$$

Check:

(a) $\frac{\Delta P}{V^2 \cdot L} = \frac{M^1L^{-1}T^{-2}}{L^2T^{-2}.L^1} = M^1L^{-4}$

(b) $\frac{V.L}{\mu} = \frac{L^1T^{-1}L^1}{M^1L^{-1}T^{-1}} = M^{-1}L^{-4}$

(c) $\frac{\Delta P}{\mu.V.L.} = \frac{M^1L^{-1}T^{-2}}{M^1L^{-1}T^{-1}.L^1T^{-1}L^1} = L^{-2}$

(d) $\frac{\Delta P.L}{\mu.V} = \frac{M^1L^{-1}T^{-2}.L^1}{M^1L^{-1}T^{-1}.L^1T^{-1}} = M^0L^0T^0$

9. ***Ans. (c)***

$$\tau \alpha \frac{du}{dy} \alpha \frac{d\theta}{dt}$$

where, θ is angular strain

$\frac{du}{dy}$ has it's unit is s^{-1} i.e., rate of strain.

10. ***Ans. (a)***

Self weight acts vertically down word

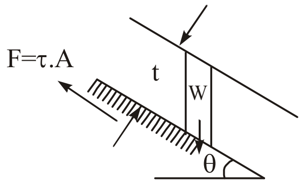
$$W = (\rho g)(\text{volume})$$

$$= \rho g(A)(t)$$

Resolving along the inclined plane,

$\rho g(A)(t)\sin\theta$

down word force = τA up word along the inclined plane.



$\rho g \; At \sin\theta = \tau.A$

$\therefore$ shear stress, $\tau = \rho gt \sin\theta$

11. ***Ans. (d)***

Viscosity is due to cohesion in liquids. As a temperature increases cohesion of liquids decrease. Hence as $T(\uparrow)\mu$ of liquids decrease. In case of gases, viscosity depends on molecular momentum exchange. As temperature, increases, molecular activity of gases increase and hence resistance to flow increase. Hence as temperature increases viscosity of gases increases.

12. ***Ans. (b)***

$$\tau = \mu\frac{du}{dy}$$

$$\frac{N}{m^2} = \mu\frac{m/s}{m}$$

$$\boxed{\mu = \left(\frac{N-s}{m^2}\right)}$$

13. ***Ans. (c)***

$$\text{Surface tension} = \frac{F}{\ell} = \frac{N}{m}\times\frac{m}{m} = J/m^2$$

14. ***Ans. (d)***

$\Delta P = \frac{4\sigma}{D}$ in case of drop.

$\Delta P = \frac{8\sigma}{D}$ in case of bubble

and hence $(\Delta P)_{bubble} = 2\;(\Delta P)_{drop}$

15. ***Ans. (a)***

For Air

$$\mu \propto \sqrt{T} \;\;\&\;\; \rho \propto 1/T$$

$$\nu = \frac{\mu}{\rho}$$

$$\nu \propto \frac{\sqrt{T}}{1/T}$$

$$\nu \propto T^{3/2}$$

16. ***Ans. (d)***

Viscosity : It is a measure of resistance of a fluid which is being deformed by either shear stress or tensile stress.

Specific gravity : It is the ratio of density of fluid to the density of standard fluid.

Capillarity : It is the ability of liquid to flow against gravity combination of surface tension and adhesion act to lift the liquid.

17. ***Ans. (a)***

Bulk modulus $K = -\frac{dp}{d\forall/\forall}$

and $\forall = \frac{m}{\rho}$

$\therefore \quad d\forall = -\frac{d\rho}{\rho^2}$

$$K = -\frac{dp}{\frac{-d\rho/\rho^2}{1/\rho}}$$

$$K = \frac{\rho dp}{d\rho}$$

18. ***Ans. (b)***

A fluid at rest there can be no shear force (i.e. viscous force). The only forces acting on the free body are the normal pressure forces, exerted by the surrounding fluid on the plane surface and the weight of the element.

19. ***Ans. (b)***

Surface tension is due to cohesion between liquid particles at the surface, where as capillarity is due to both cohesion and adhesion.

The property of cohesion enables a liquid to resist tensile stress, while adhesion enables it to stick to another body.

20. ***Ans. (c)***

Newton's law of viscosity

$\tau = \mu\frac{du}{dy}$ Where τ = shear stress

$\frac{du}{dy}$ = Rate of strain

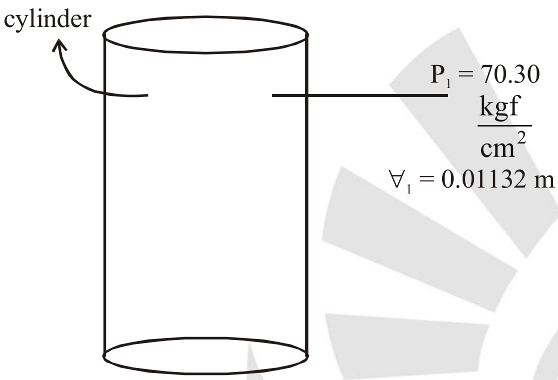
21. *Ans. (d)*

Pressure intensity inside a droplet

$$\Delta P = \frac{4\sigma}{d} = \frac{4 \times 0.073}{10^{-3}} N/m^2 = 292\, N/m^2$$

22. *Ans. (b)*

$$P_1 = 70.30 \frac{kgf}{cm^2}$$



$$\forall_1 = 0.01132 m^3$$
$$\forall_2 = 0.01121 m^3$$
$$\Delta\forall = \forall_2 - \forall_1 = 0.01121 m^3 - 0.01132 m^3$$
$$= -1.1 \times 10^{-4}\ m^3$$

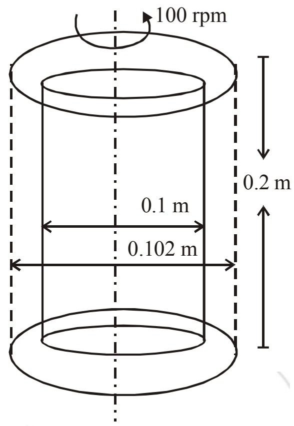
$$k = \frac{dp}{-d\forall \mid \forall} (\text{Bulk mod ulus})$$

$$7034 \frac{kgf}{cm^2} = \frac{P_2 - 70.30 \frac{kgf}{cm^2}}{\frac{-1.1 \times 10^{-4} m^3}{0.01132 m^3}}$$

$$P_2 = 138.61 \frac{kgf}{cm^2} = 135\, MPa$$

23. *Ans. (a)*

$$\mu = 1\, poise$$
$$= 0.1 \frac{N \cdot s}{m^2}$$



if fluid is Rotating then

$$\tau \propto \frac{du}{dy} \propto \dot{\theta}$$

$$\tau = \mu \frac{du}{dy}$$

and if velocity profile is linear (narrow gap)

$$\tau = \mu \left(\frac{u_2 - u_1}{y_2 - y_1} \right) = \frac{\mu \omega R_1}{R_2 - R_1}$$

$$\omega = \frac{2\pi N}{60} (\text{angular velocity})$$

$$\tau = \frac{\mu 2\pi N \times R_1}{60(R_2 - R_1)} (\text{shear stress})$$

$$F = \tau A = \tau \times 2\pi R_1 L (\text{shear force})$$

hence torque is given by.

$$T = F \times R_1 = \tau \times 2\pi R_1^2 L$$

$$T = 0.1645\, N \cdot m$$

24. *Ans. (a)*

$$\frac{\Delta V}{V} = -0.002$$

$$P_1 = 6.867 \times 10^6 \frac{N}{m^2}$$

$$P_2 = 15.696 \times 10^6 \frac{N}{m^2}$$

hence bulk modulus is

$$K = \frac{-dp}{d\forall \,|\, \forall} = \frac{\left(15.696\times10^6 - 6.86\times10^6\right)}{0.002}\frac{N}{m^2}$$

$$= 4.418\times10^9\,\frac{N}{m^2}$$

$$= 4418\,MN/m^2$$

25. ***Ans. (c)***

Given that

$$\mu(\text{dynamic cis cosity}) = 0.048\times10^{-1}\,\frac{N-s}{m^2}$$

$\upsilon = 3.50 \times 10^{-2}$ stroke

$= 3.50 \times 10^{-6}\ m^2/sec$

we know that

$$\frac{\mu}{\rho} = \upsilon$$

$$\upsilon = \left(\frac{\mu}{\rho}\right) = \frac{0.048\times10^{-1}\,\frac{N-s}{m^2}}{3.50\times10^{-6}\,m^2/sec}$$

$$\rho = 1.31742\ kg/m^3$$

$$S = \frac{\rho}{1000}$$

$$S = 1.31742$$

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