VISCOSITY

1. The property of viscosity in gas is due to:

1) Cohesive forces between the molecules
2) Collisions between the molecules
3) Not having a definite volume
4) Not having a definite size

2. When temperature is increased

a) Viscosity of the gas increases

b) Viscosity of the gas decreases

c) Viscosity of the liquid decreases

d) Viscosity of the liquid increases

1) (a) and (c) are true
2) (b) and (c) are true
3) (b) and (d) are true
4) (a) and (d) are true

3. The Reynolds's number for fluid flow in a pipe does not depend on

(a) the length of the pipe
(b) the diameter of the pipe
(c) the viscosity of the fluid
(d) the density of the fluid

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

4. [A]: Heavy machineries require high viscous oil while light machineries require low viscousoil.

[R]: The internal friction developed in the relative motion depends upon viscosity.

1. If both Assertion and Reason are true and Reason is correct explanation of Assertion.
2. If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.
3. If Assertion is true but Reason is false.
4. If both Assertion and Reason are false.

5. **[A]: The blood pressure in humans is greater at the feet than at the brain.**

[R]: Pressure of liquid at any point is proportional to height, density of liquid and acceleration due to gravity.

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3. If Assertion is true but Reason is false.
4. If both Assertion and Reason are false.

6. **[A]: During takeoff of an aero plane, velocity of air above the wing is greater than bellow the wing.**

[R] :Bernoulli's principle is based on law of conservation of energy.

1. If both Assertion and Reason are true and Reason is correct explanation of Assertion.
2. If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.
3. If Assertion is true but Reason is false.
4. If both Assertion and Reason are false.

7. **Which of the following are/is not practical example of capillarity action?**

1) If one end of a towel is dipped in water filled vessel, then after some time the entire towel is wet.
2) Writing nib is split in the middle.
3) The designing of the aero plane wings such that the curvature of its upper surface is greater than that of the lower.
4) Ploughing of fields helps retain moisture in them.

8. **When an air bubble moves up from the bottom of a deep is lake,**

a) its acceleration is constant
b) its acceleration decreases and becomes zero
c) its velocity decreases and becomes constant
d) its velocity increases and becomes constant

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

9. **Match the following in List – I and List – II**

List – I	**List – II**
a) Pascal's law	**e) Venturimeter**
b) Archimedes's principle	**f) Efflux velocity**
c) Bernoulli's equation	**g) Hydraulic press**
d) Torcille's theorem	**h) Hygrometer**

1) a – h, b – e, c – f, d – g 2) a – h, b – g, c – e, d – f

3) a – g, b – h, c – e, d – f 4) a – g, b – e, c – f, d – h

10. **A): The shape of an automobile is so designed that its front resembles the stream line pattern of the fluid through which it moves.**

R): The resistance offered by the fluid is maximum.

1) Both 'A' and 'R' are true and 'R' is the correct explanation of 'A'

2) Both 'A' and 'R' are true and 'R' is not the correct explanation of 'A'

3)'A' is true and 'R' is false 4)'A' is false and 'R' is true

11. **A) : Machine parts are jammed in winter.**

R) : The viscosity of lubricant used in machine parts increase at low temperature.

1) Both 'A' and 'R' are true and 'R' is the correct explanation of 'A'

2) Both 'A' and 'R' are true and 'R' is not the correct explanation of 'A'

3)'A' is true and 'R' is false 4)'A' is false and 'R' is true

12. **Arrange the following liquids in the increasing order of their viscosity.**

a) Castor oil b) Mercury c) Benzene d) Glycerin

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

13. **The tangential force (or) viscous force on any layer of the liquid is directly proportional to velocity gradient. Then the direction of velocity gradient is :**

1. Perpendicular to the direction of flow of liquid

2. Parallel to the direction of flow of liquid

3. Opposite to the direction of flow of the liquid

4. Independent of the direction of flow of liquid.

14. An ideal fluid is flowing through four tubes a, b, c, d of radii in the ratio 2 : 7 : 3 : 1 with velocities in the ratio 1 : 2 : 5 : 15 when maintained at different pressures. The ascending order of the amount of fluid flowing through the tubes per second is

1) a, d, c, b   2) b, c, d, a   3) c, p, b, a   4) b, c, d, a

15. A square plate of 0.1 m side moves parallel to a second plate with a velocity of 0.1 m/s, both plates being immersed in water. If the viscous force is 0.002 N and the coefficient of viscosity is 0.01 poise, distance between the plates in m is

1) 0.1   2) 0.05   3) 0.005   4) 0.0005

16. Water is allowed to flow through a capillary tube of length 10cm and diameter 2 mm under a constant pressure difference of 6.5 cm of water level. If 0.16 litres of water flows in 1 minute, its coefficient of viscosity is,

1) 0.00937 poise   2) 0.0937 poise   3) 0.000937 poise   4) 0.937 poise

17. A metal ball of radius 'r' and density'd' travels with a terminal velocity 'v' in a liquid of density d/4. The terminal velocity of another ball of radius '2r' and density '3d' in the same liquid is

1) $\frac{44v}{3}$ 2) $\frac{22v}{3}$ 3) $\frac{11v}{3}$ 4) $\frac{3v}{44}$

18. Two metal spheres of densities in the ratio 3 : 2 and diameter in the ratio 1 : 2 are released from rest in two vertical liquid columns of coefficients of viscosity in the ratio 4 : 3. If the viscous force on them is same, then the ratio of their instantaneous velocities is

1) 1 : 2   2) 3 : 2   3) 4 : 3   4) 8 : 3

19. The terminal velocity of a small ball falling in a viscous liquid depends upon i) its mass m ii) its radius r iii) the coefficient of viscosity of the liquid and iv) acceleration due to gravity. Which of the following relations is dimensionally true for the terminal velocity V =

1) $\frac{Kmg}{\eta r}$ 2) $\frac{Kmgr}{\eta}$ 3) $\frac{Kmg\eta}{r}$ 4) $\frac{Kr\eta}{mg}$

20. The coefficients of viscosity of two liquids are in the ratio 2 : 3. What is the ratio of the volumes of liquid collected in the same time using the same vessel completely filled with liquids of densities in the ratio 4 : 5 ? (The capillary tubes used have the same length and same bore diameter.)

1) 8 : 15 2) 6 : 5 3) 5 : 6 4) 15 : 8

21. When water (h=0.01 poise) and benzene (h = 0.0065 poise) are allowed to flow through capillary tube, it was found that the same amount of liquids are collected in the same time. But the pressures that caused the flow are different. The pressure on water is 0.015 atmosphere, the corresponding pressure for benzene in atmosphere is

1) 0.0975 2) 0.00975 3) 0.975 4) 9.75

22. Two rain drops reach the earth with their terminal velocities in the ratio 4:9. The ratio of their radii is

1) 4:9 2) 2:3 3) 3:2 4) 9:4

23. A solid rubber ball of density d and radius R falls through air. Assume that the air resistance acting on the ball is KRV, where V is velocity of the ball and K is a constant. The terminal velocity attained by the ball is

1) $4\pi R^2 dg/3K$ 2) $4\pi Rdg/3K$ 3) $4\pi Rd^2 g/3K$ 4) None

24. In a planet a sucrose solution of coefficient of viscosity 0.0015N-Sm^{-2} is driven at a velocity of 10^{-3}ms^{-1} through xylem vessels of radius 2μm and length 5μm. The hydrostatic pressure difference across the length of xylem vessels in Nm^{-2} is

1) 5 2) 8 3) 10 4) 15

25. Two capillary tubes of radius r but of lengths ℓ_1 and ℓ_2 are fitted in parallel to the bottom of a vessel. The pressure head is P. What should be the length of a single tube that can replace the two tubes so that the rate of flow is same as before?

1) $\ell_1 + \ell_2$ 2) $\frac{1}{\ell_1} + \frac{1}{\ell_2}$ 3) $\frac{\ell_1 \ell_2}{\ell_1 + \ell_2}$ 4) $\frac{1}{\ell_1 + \ell_2}$

26. In the above if the lengths are same and radii are r_1 and r_2 then

1) $\left(r_1^2 + r_2^2\right)^{\frac{1}{2}}$ 2) $\left(r_1^3 + r_2^3\right)^{\frac{1}{3}}$ 3) $\left(r_1^4 + r_2^4\right)^{\frac{1}{4}}$ 4) $\left(r_1 + r_2\right)^{\frac{1}{2}}$

27. **The rate of steady volume flow of water through a capillary tube of length 'l' and radius 'r' under a pressure difference of P is V. This tube is connected with another tube of the same length but half the radius in series. Then the rate of steady volume flow through them is (The pressure difference across the combination is P)**

1) $\frac{V}{16}$ 2) $\frac{V}{17}$ 3) $\frac{16V}{17}$ 4) $\frac{17V}{16}$

28. **In the above if the tubes are parallel; the rate of flow is given by**

1) $\frac{V}{16}$ 2) $\frac{V}{17}$ 3) $\frac{16V}{17}$ 4) $\frac{17V}{16}$

29. **A cylindrical vessel of height 'h is kept maintained with full of water. The capillary tube of equal length l and radii r is arranged at $\frac{h_1}{2}, \frac{3h}{4}, h$ from the top. The length of the equivalent tube of same radius which can replace these three tubes, that is arranged at $\frac{3h}{4}$ from the top.**

1) $L = \frac{l}{3}$ 2) $L = \frac{2l}{3}$ 3) $L = \frac{l}{6}$ 4) $L = \frac{5l}{3}$

30. **We have two (narrow) capillary tubes T_1 and T_2. Their lengths are l_1 and l_2 and radii of cross-section are r_1 and r_2 respectively. The rate of flow of water under a pressure difference P through tube T_1 is 8cm^3/sec. If $l_1 = 2l_2$ and $r_1 = r_2$, what will be the rate of flow when the two tubes are connected in series and pressure difference across the combination is same as before (= P)**

1) 4 cm^3/sec 2) (16/3) cm^3/sec

3) (8/17) cm^3/sec 4) None of these

KEY

1) 2 2)1	3)4	4)1	5)1	6)2	7)3	8) 4	9) 3	10) 3	
11) 1	12) 4	13) 1	14) 4	15) 4	16) 1	17) 1	18) 2	19) 1	20) 2
21) 2	22) 2	23)1	24)4	25)3	26)3	27)2	28)4	29)1	30)2

HINTS

15. $F = \eta A \frac{d\upsilon}{dx}$

$0.002 = 0.01 \times 10^{-1} \times 0.01 \times \frac{0.1}{dx}$

$dx = \frac{10^{-6}}{2 \times 10^{-3}}$

= 0.5 x 10^{-3}m = 0.0005 m

16. $Q = \frac{\pi}{8} \frac{\Pr^4}{l\eta}$

$Q = \frac{\pi}{8} \frac{(h\rho g) r^4}{l\eta}$

$\frac{160}{60} = \frac{3.14}{8} \times \frac{6.5 \times 1 \times 980 \times (0.1)^4}{10 \times \eta}$

$\therefore \eta = \frac{3.14 \times 6.5 \times 98 \times 10^{-4} \times 6}{16 \times 8}$ = 93.7 x 10^{-4} = 0.00937 Poise

17. $\upsilon_t = \frac{2}{9} \frac{r^2 (d - \rho) g}{\eta}$

$\upsilon_t \propto r^2 (\rho - \sigma)$

$\frac{\upsilon}{\upsilon_{t_2}} = \frac{1}{4} \frac{\frac{3d}{4}}{\frac{11d}{4}}$

$\therefore \upsilon_{t_2} = \frac{44v}{3}$

18. $6\pi\eta_1 r_1 \upsilon_1 = 6\pi\eta_2 r_2 \upsilon_2$

$\frac{\upsilon_1}{\upsilon_2} = \frac{\eta_2}{\eta_1} \cdot \frac{r_2}{r_1}$

$= \frac{3}{4} \times \frac{2}{1} = 3:2$

19. i) $\frac{kmg}{\eta r} = \frac{M(LT^{-2})}{(ML^{-1}T^{-1})(L)} = LT^{-1}$

ii) $\frac{kmgr}{\eta} = \frac{M(LT^{-2})(L)}{(ML^{-1}T^{-1})} = L^3T^{-1}$

iii) $\frac{kmg\eta}{r} = \frac{(M)(LT^{-2})}{L}(ML^{-1}T^{-1}) = M^2L^{-1}T^{-3}$

iv) $\frac{kr\eta}{mg} = \frac{(L)(ML^{-1}T^{-1})}{M(LT^{-2})} = L^{-1}T$

20. $V = \frac{\pi}{8} \cdot \frac{\Pr^4}{l\eta} t$

$V = \frac{\pi}{8} \cdot \frac{(hdg)\,\mathrm{r}^4}{l\eta} t$

$\therefore \frac{V_1}{V_2} = \frac{d_1}{d_2} \cdot \frac{\eta_2}{\eta_1}$

$\therefore \frac{V_1}{V_2} = \frac{4}{5} \times \frac{3}{2} = 6:5\,\mathrm{s}$

21. $V = \frac{\pi}{8} \cdot \frac{\Pr^4}{l\eta} t$

$\therefore \frac{P}{\eta} = \mathrm{co}\,nst$

$\therefore \frac{P_1}{P_2} = \frac{\eta_1}{\eta_2} \Rightarrow \frac{0.015}{P_2} = \frac{0.01}{0.0065} = 0.00975$ atm

22. $\upsilon_t \propto r^2$

$\frac{\upsilon_{t_1}}{\upsilon_{t_2}} = \frac{r_1^2}{r_2^2}$

$\frac{4}{9} = \frac{r_1^2}{r_2^2}$ $\qquad \therefore \frac{r_1}{r_2} = \frac{2}{3}$

23. F = KRV

Mg = KRV_t

$$\frac{4}{3}\pi R^3 dg = KRV_t$$

$$\therefore \upsilon_t = \frac{4\pi R^2 dg}{3K}$$

24. $Q = \frac{\pi \Pr^4}{8\eta l}$

$$\therefore A\upsilon = \frac{\pi}{8}.\frac{\Pr^4}{l\eta}$$

$$P = \frac{8\times10^{-3}\ 5\times10^{-6}\times0.0015}{4\times10^{-12}} = 15\ N/m^2$$

25. Q = $Q_1 + Q_2$

$$\therefore \frac{1}{l} = \frac{1}{l_1} + \frac{1}{l_2}$$

$$\therefore l = \frac{l_1 l_2}{l_1 + l_2}$$

26. $r^4 = r_1^4 + r_2^4 \quad \Rightarrow r = \left(r_1^4 + r_2^4\right)^{1/4}$

27. $Q = \frac{\pi \Pr^4}{8\eta l}$

$$Q^1 = \frac{P}{\frac{8\eta}{\pi}\left[\frac{l_1}{r_1^4} + \frac{l_2}{r_2^4}\right]}$$

$$Q^1 = \frac{P}{\frac{8\eta}{\pi}\left[\frac{l_1}{r^4} + \frac{16l}{r^4}\right]} = \frac{V}{17}$$

28. $V_1 = \frac{\pi P r^4}{8\eta l}$; $V_2 = \frac{\pi P r^4}{8\eta l \times 16} = \frac{V}{16}$

$$V = V_1 + V_2 = V + \frac{V}{16} = \frac{17V}{16}$$

29. $V = V_1 + V_2 + V_3$

$$\frac{P}{L} = \frac{P_1 + P_2 + P_3}{l} \Rightarrow \frac{3h}{4L} = \frac{\frac{h}{2} + \frac{3h}{4} + h}{l} \Rightarrow L = \frac{l}{3}$$

30. $V = \frac{\pi \,\mathrm{Pr}^4}{8\eta l} = \frac{8cm^3}{\sec}$

For composite tube

$$V_1 = \frac{P\pi r^4}{8\eta\left(l + \frac{l}{2}\right)} = \frac{2}{3}\frac{\pi P r^4}{8\eta l} = \frac{2}{3} \times 8 = \frac{16}{3}\frac{cm^3}{\sec} \qquad \left[\because\ l_1 = l = 2l_2 \text{ or } l_2 = \frac{l}{2}\right]$$