FLUID MECHANICS

PREVIOUS EAMCET QUESTIONS

ENGINEERING

1. Eight spherical rain drops of the same mass and radius are falling down with a terminal speed of 6cm-s^{2}. If they coalesce to form one big drop, what will be the terminal speed of bigger drop? (Neglect the buoyancy of the air) **(ENGG-2009)**

1.5cm-s^{-1} 2)6cm-s^{-1} 3) 24 cm-s^{-1} 4) 32cm-s^{1}

Ans : 3

Sol: As the volume remains constant

$$V_1 = V_2$$

$$\Rightarrow \frac{4}{3}\pi R^3 = n\left(\frac{4}{3}\pi r^3\right)$$

$$\Rightarrow R = n^{1/3} r = (8)^{1/3} r = 2r$$

As terminal velocity $(V_T) \propto r^2$

$$\frac{V_1}{V_2} = \left(\frac{r}{R}\right)^2 = \left(\frac{r}{2r}\right)^2$$

$$\frac{V_1}{V_2} = \frac{1}{4} \Rightarrow V_2 = 4\times 6 = 24cms^{-1}$$

2. Two rain drops reach the earth with different terminal velocities having ratio 9:4. Then the ratio of their volume is **(2008E)**

1) 3:2 2)4:9 3)9:4 4)27:8

Ans : 4

Sol: V_t = Terminal Velocity= $\frac{2r^2 g(\rho-\sigma)}{9\eta} \Rightarrow V_t \propto r^2$

$$\therefore \frac{V_1}{V_2} = \left(\frac{r_1}{r_2}\right)^2 \Rightarrow \frac{9}{4} = \left(\frac{r_1}{r_2}\right)^2 \Rightarrow \frac{r_1}{r_2} = \frac{3}{2}$$

Volume of a spherical drop = $\frac{4}{3}\pi r^3$

$$\therefore \frac{V_1}{V_2} = \left(\frac{r_1}{r_2}\right)^3 = \left(\frac{3}{2}\right)^2 = \frac{27}{8}$$

3. A horizontal pipe of non-uniform cross-section allows water to flow through it with a velocity 1ms^{-1} when pressure is 50kPa at a point. If the velocity of flow has to be 2 ms^{-1} at some other point, the pressure at that point should be **(2007E)**

1) 50 kPa 2) 100kPa 3) 48.5 kPa 4) 24.25 kPa

Ans:3

Sol: According to the Bernoullis theorem

$$P_1 + \frac{1}{2}PV_1^2 = P_2 + \frac{1}{2}PV_2^2$$

$$\therefore P_2 = P_1 + \frac{1}{2}\left(PV_1^2 - PV_2^2\right)$$

$$= 50\times10^3 + \frac{1}{2}\times10^3\left(1^2 - 2^2\right)$$

= 48.5 Kpa

4. An air bubble of radius 1cm rises from the bottom portion through a liquid of density 1.5g/cc at a constant speed of $0.25cm^{-1}$. If the density of air is neglected, the coefficient of viscosity of the liquid is approximately, (in P as) **[2006 E]**

1) 13,000 2) 1,300 3) 130 4) 13

Ans : 3

Sol: From stokes formula F = $6\pi\eta rv = \eta = \frac{F}{6\pi rv}$

$$= \frac{\frac{4}{3}\pi r^3 pg}{6\pi rv}$$

$$= \frac{2r^2 pg}{9v}$$

= 130Pas

5. 5. An iron sphere of mass 20x 10^{-3} kg falls through a viscous liquid with terminal velocity $0.5ms^{-1}$. The terminal velocity (in ms^{-1}) of another iron sphere of mass 54 x 10^{-2}kg is: **(2005E)**

1) 4.5 2) 3.5 3) 2.5 4) 1.5

Ans: 1

Sol: Terminal velocity $(v) \propto r^2$

Given $\frac{m_1}{m_2} = \frac{20\times10^{-3}}{54\times10^{-2}} = \frac{1}{27}$

But mass = volume × density = $\left(\frac{4}{3}\pi r^3\right)p$

$$\therefore \frac{m_1}{m_2} = \left(\frac{r_1}{r_2}\right)^3 = \frac{1}{27}$$

$$\therefore \left(\frac{r_1}{r_2}\right) = \frac{1}{3}$$

Terminal velocity $\propto$ (radius)^2

$$\therefore \frac{V_1}{V_2} = \left(\frac{r_1}{r_2}\right)^2 = \left(\frac{1}{3}\right)^2 = \frac{1}{9}$$

$$\therefore V_2 = 9\times0.5 = 4.5ms^{-1}$$

6. Water in a river 20m deep is flowing at a speed of $10ms^{-1}$. The shearing stress between the horizontal layers of water in the river in Nm^{-2} is : (coefficient of viscosity of water = 10^{-3} SI units) **(2004E)**

1) 1 x 10^{-2} 2) 0.5 x 10^{-2} 3) 1 x 10^{-3} 4) 0.5 x 10^{-3}

Ans : 4

Sol: $$F = \eta A\left(\frac{dv}{dx}\right) \Rightarrow \frac{F}{A} = \eta.\left(\frac{dv}{dx}\right)$$

$$= 0.5\times10^{-3}\,Nm^{-2}$$

7. There are two holes one each along the opposite sides of a wide rectangular tank. The cross section of each hole is 0.01m² and the vertical distance between the holes is one meter. The tank is filled with water. The net force on the tank in Newton when water flows out of the holes is: (Density of water 1000kg/m³) **(2004 E)**

1) 100 2) 200 3) 300 4) 400

Ans: 1

Sol: Net force on the tank = $F_1 - F_2$ = $\rho_1 A - \rho_2 A$

$= (\rho_1 - \rho_2) A$

But $P_1 - P_2$ = $(h_1\rho g - h_2\rho g)$

$= \rho g(h_1 - h_2) = \rho g h$

$\therefore F_{net}$ = pgh A = $1\times10^3\times10\times0.01 = 100N$

8. 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 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) **[2003]**

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

Ans : 2

Sol: Rate of volume flow in a single tube

$$V_1 = \frac{\pi p r_1^4}{8\eta l_1} \text{ ………………(1)}$$

Rate of volume flow when both the tubes joined in series

$$V_2 = \frac{\pi p}{8\eta\left[\frac{l_1}{r_1^4} + \frac{l_2}{r_2^4}\right]} \text{ ………………(2)}$$

Dividing (1) & (2)

$$\frac{V_1}{V_2} = \frac{\frac{r_1^4}{l_1}}{\left(\frac{l_1}{r_1^4} + \frac{l_2}{r_2^4}\right)}$$

On simplifying we get $V_2 = \frac{V}{17}$

9. A water barrel having water up to depth 'd' is placed on a table of height 'h'. A small hole is made on the wall of the barrel at its bottom. If the stream of water coming out of the hole falls on the ground at a horizontal distance 'R' from the barrel, then the value of 'd' is **(2002E)**

1. $\frac{4h}{R^2}$ 2. $4hR^2$ 3. $\frac{R^2}{4h}$ 4. $\frac{h}{4R^2}$

Ans : 3

Sol: Horizontal range = R = $u\sqrt{\frac{2h}{g}}$

But $u = \sqrt{2gd}$

$$\therefore R = \sqrt{2gd}\sqrt{\frac{2h}{g}} = \sqrt{4hd}$$

$$\Rightarrow d = \frac{R^2}{4h}$$

10. Tanks A and B open at the top contain two different liquids upto certain height in them. A hole is made on the wall of each tank at a depth 'h' from the surface of the liquid. The area of the hole in 'A' is twice that of in B. If the liquid mass flux through each hole is equal, then the ratio of the densities of the liquids respectively is **(2002E)**

1. $\frac{2}{1}$ 2. $4hR^2$ 3. $\frac{R^2}{4h}$ 4. $\frac{h}{4R^2}$

Ans : 4

Sol: When know $\rho_1 a_1 v_1 = \rho_2 a_2 v_2$ [equation of continuity]

$$\Rightarrow \rho_1 a_1 = \rho_2 a_2 = \rho_2\left(\frac{a_1}{2}\right)$$

$$\Rightarrow \frac{\rho_1}{\rho_2} = \frac{1}{2} = \frac{\rho_A}{\rho_B}$$

11. Water is conveyed through a uniform tube of 8 cm in diameter and 3140m in length at the rate of per second. The pressure required to maintain the flow is (viscosity of water = 10^{-3} S.I. units) **2001E)**

1. 6.25 Nm^{-2} 2. 0.625 Nm^{-2} 3. 0.0625 Nm^{-2} 4. 0.00625 Nm^{-2}

Ans: No option is correct

Sol: Pressure P = $\frac{8\eta / v}{\pi r^2}$

$$P = \frac{\left(8\times10^{-3}\right)\left(3140\right)\left(2\times10^{-3}\right)}{\left(3.14\right)\left(4\times10^{-2}\right)^4}$$

= 6250 Nm^{-2}

$$= 4.15\pi\times10^{-7}\,J$$

12. A tank with vertical walls is mounted so that its base is at a height H above the horizontal ground. The tank is filled with water to a depth 'h' . A hole is punched in the side wall of the tank at a depth '' below the water surface. To have maximum range of the emerging stream, the value of x is

(2001 E)

1. $\frac{H+h}{4}$ 2. $\frac{H+h}{2}$ 3. $\frac{H+h}{3}$ 4. $\frac{3(H+h)}{4}$

Ans: 2

Sol: Range = horizontal velocity x time of flight

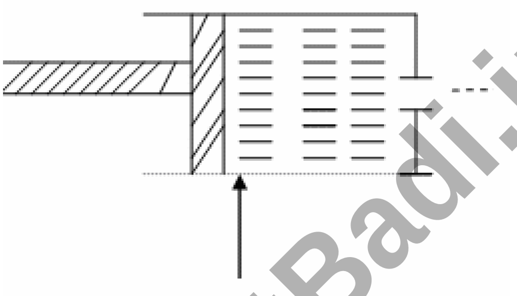
$R = \sqrt{2g(h-x)} \times \sqrt{\frac{2H}{g}}$

to have maximum range $\frac{dR}{dx} = 0 \;\; on \; solivngx = \frac{H+h}{2}$

MEDICAL

13. A syringe of diameter 1cm having a nozzle of diameter 1mm, is placed horizontally at a height 5m from the ground as shown below . An incompressible non-viscous liquid is compressed by moving the piston at a speed of 0.5 m/s, the horizontal distance travelled by the liquid jet : (g=10 ms^{-2})

(2009 M)



1) 12.5 m 2) 25 m 3)50 m 4) 75 m

Ans: 3

Sol: According to the equation of continuity

$$A_1V_1 = A_2V_2$$
$$\Rightarrow \pi r_1^2 v_1 = \pi r_2^2 v_2$$
$$\Rightarrow \pi\left(0.5\times10^{-2}\right)^2(0.5) = \pi\left(0.5\times10^{-3}\right)^2 v_2$$
$$\Rightarrow v_2 = 50ms^{-1}$$

$\therefore$ Range $R = u\sqrt{\frac{2h}{g}}$

$R = 50\sqrt{\frac{2(5)}{10}} = 50m$

14. A solid sphere falls with a terminal velocity 'V' in gas. If it is allowed to fall in vacuum **(2008M)**
1)Terminal velocity of sphere = V
2)Terminal velocity of sphere < V
3)Terminal velocity of sphere > V
4)Sphere never attains terminal velocity

Ans: 4

Sol: In vaccum, the solid sphere doesn't attain terminal velocity

15. The pressure on the top surface of an aeroplane wing is 0.8 x 10^5 Pa and the pressure on the bottom surface is 0.75 x 10^5 Pa. If the area of each surface is 50m^2, the dynamic lift on the wing is

(2007M)

1) 25×10^4 N 2) 0.5×10^4 N 3) 5×10^4 N 4) 0.25×10^5 N

Ans:1

Sol: Dynamic lift on the wing = F= (P_1 - P_2) A

$$= (0.8 - 0.75) \times 10^5 \times 50$$
$$= 25 \times 10^4 N$$

16. The speeds of air-flow on the upper and lower surfaces of a wing of an aeroplane are v_1 and v_2 respectively. If A is the cross-sectional area of the wing and 'ρ' is the density of air, then the upward lift is: **(2006 M)**

1) $\frac{1}{2}\rho A(v_1 - v_2)$ 2) $\frac{1}{2}\rho A(v_1 + v_2)$ 3) $\frac{1}{2}\rho A(v_1^2 - v_2^2)$ 4) $\frac{1}{2}\rho A(v_1^2 + v_2^2)$

Ans: 3

Sol: upward lift = pressure difference $\times$ area of wings

From bernoullis theorem $P_1 + \frac{1}{2}\rho V_1^2 = P_2 + \frac{1}{2}\rho V_2^2$

$$\therefore P_2 - P_1 = \frac{1}{2}\rho\left(V_1^2 - V_2^2\right)$$

$\Rightarrow$ upward lift $= \frac{1}{2}\rho A\left(V_1^2 - V_2^2\right)$

17. Two rain drops reach the earth with their terminal velocities in the ratio 4:9. The ratio of their radii is: **(2005M)**

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

Ans: 2

Sol : Terminal velocity of rain drop of radius r and density ρ traveling in air of density σ is given as

$$V_t = \frac{2r^2(\rho - \sigma)g}{9\eta}$$

$$\therefore \frac{V_1}{V_2} = \left(\frac{r_1}{r_2}\right)^2 \Rightarrow \frac{4}{9} = \left(\frac{r_1}{r_2}\right)^2 \Rightarrow \frac{r_1}{r_2} = \frac{2}{3}$$

18. When temperature is increased: **(2004M)**

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 trueAns:1

Sol: When temperature is increased viscosity of gases increase because of exchange of momentum. Viscosity of liquids decreases because on heating distance between the molecules increases and hence force of attraction decreases

19. A square plate of 0.1 metre 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 newton and the coefficient of viscosity is 0.01 poise, distance between the plates in metre is **(2003 M)**

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

Ans :4

Sol: From newtons formula of viscosity

$$F = \eta A\left(\frac{dv}{dx}\right) \Rightarrow dx = \frac{\eta A dv}{F}$$

$$= \frac{10^{-3} \times 10^{-2} \times 10^{-1}}{2 \times 10^{-3}}$$

$$= 5 \times 10^{-4} m$$

20. An aeroplane of mass kg and total wing area 120m² is in a level flight at same height. The difference in pressure between the upper and lower surface of its wings in Kilo Pascal is (g = 10 ms^{-2}) **(2002M)**

1. 2.5 2. 5.0 3. 10.0 4. 12.5

Ans: 1

Sol: $(P_2 - P_1) A = mg$

$$\Rightarrow P_2 - P_1 = \frac{mg}{A} = \frac{(3 \times 10^4)(10)}{120} = 2.5 K\ Pa$$

21. In a plant, sucrose solution of coefficient of viscosity 0.0015 $N.m^{-2}$ is driven at a velocity of 10^{-3} m s^{-1} through xylem vessels of radius 2 and length 5 . The hydrostatic pressure difference across the length of xylem vessels in is : **(2002M)**

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

Ans : 4

Sol : $\frac{\pi P a^4}{8\eta l} = v = \pi a^2 \vartheta$ [from Poiseuille's equation and equation of continuity]

$$\therefore P = \frac{8\vartheta\eta l}{r^2} = \frac{8 \times 10^{-3} \times \frac{15}{10^4} \times \frac{5}{10^6}}{\left(\frac{2}{10^6}\right)}$$

$$= \frac{60}{4} = 15\, N/m^2$$

22. A liquid is flowing in a horizontal uniform capillary tube under a constant pressure difference P. The value of pressure for which the rate of flow of the liquid is doubled when the radius and length are doubled is **(2001M)**

1. P 2. $\frac{3P}{4}$ 3. $\frac{P}{2}$ 4. $\frac{P}{4}$

Ans : 4

Sol: We know $\eta = \frac{\pi \Pr^4}{8vl}$

$$\therefore \frac{P_1}{P_2} = \frac{l_1 v_1}{l_2 v_2} \times \frac{r_2^4}{r_1^4} = \left(\frac{l_1}{2l_1}\right)\left(\frac{v_1}{2v_1}\right)\left(\frac{16r^4}{r^4}\right)$$

$$\frac{P_1}{P_2} = 4 \Rightarrow P_2 = \frac{P_1}{4} = \frac{P}{4}$$