

Fluid Mechanics

Question1

Water is filled in a tank up to a height of 20 cm from the bottom of the tank. Water flows through a hole of area 1 mm^2 at its bottom. The mass of the water coming out from the hole in a time of 0.6 s is

TG EAPCET 2025 (Online) 2nd May Evening Shift

Options:

A.

1.8 g

B.

1.2 g

C.

0.6 g

D.

2.4 g

Answer: B

Solution:

Height of water $h = 20 \text{ cm}$

$$= 20 \times \frac{1}{100} \text{ m} = 0.2 \text{ m}$$

Velocity of efflux



$$v = \sqrt{2gh} = \sqrt{2 \times 10 \text{ m/s}^2 \times 0.2 \text{ m}}$$

$$v = \sqrt{4 \text{ m}^2/\text{s}^2} = 2 \text{ ms}^{-1}$$

Volume flow rate

$$Q = A \times V$$

$$Q = 1 \text{ m}^2 \times 2 \text{ m/s} = 2 \text{ m}^3/\text{s}$$

Volume of water $V = Q \times t$

$$V = 2 \text{ m}^3/\text{s} \times 0.6 \text{ s} = 1.2 \text{ m}^3$$

Mass of the water

$$m = \rho \times V$$

$$m = 1000 \text{ kg/m}^3 \times 1.2 \text{ m}^3$$

$$= 1200 \text{ kg} = 1.2 \text{ g}$$

Question2

For which of the following Reynold's number, a flow is streamlined?

TG EAPCET 2025 (Online) 2nd May Evening Shift

Options:

A.

900

B.

2100

C.

2900

D.

4000

Answer: A

Solution:



For stream line flow

$$R_e < 1000$$

Thus, for $R_e = 900$, flow of liquid is streamlined.

Question3

The work done in blowing a soap bubble of diameter 3 cm is (surface tension of soap solution = 0.035Nm^{-1})

TG EAPCET 2025 (Online) 2nd May Morning Shift

Options:

A.

$$792\mu\text{ J}$$

B.

$$99\mu\text{ J}$$

C.

$$396\mu\text{ J}$$

D.

$$198\mu\text{ J}$$

Answer: D

Solution:

$$d = 3\text{ cm}$$

$$r = \frac{3}{2} \times 10^{-2}\text{ m}$$

$$T = 0.035\text{Nm}^{-1}$$

For soap bubble, both inner and outer surface contributes, so increase in surface area is

$$\Delta A = 2 \times 4\pi r^2 = 8\pi r^2$$

Work done = Surface tension \times Increase in area



$$\begin{aligned}W &= T \times \Delta A \\ &= 0.035 \times 8 \times \pi \times \left(\frac{3}{2} \times 10^{-2}\right)^2 \\ &\approx 1.98 \times 10^{-4} \text{ J} \approx 198 \mu \text{ J}\end{aligned}$$

Question4

If the terminal velocity of a metal sphere of mass 8 g falling through a liquid is 3cms^{-1} , then the terminal velocity of another sphere of mass 64 g made of the same metal falling through same liquid is

TG EAPCET 2025 (Online) 2nd May Morning Shift

Options:

A.

$$6\text{cms}^{-1}$$

B.

$$3\text{cms}^{-1}$$

C.

$$12\text{cms}^{-1}$$

D.

$$18\text{cms}^{-1}$$

Answer: C

Solution:

We know that terminal velocity

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

$$\Rightarrow v \propto r^2 \quad \dots (i)$$

But mass of sphere



$$m = \frac{4}{3}\pi r^3 \rho$$

$$\Rightarrow r^3 \propto m$$

$$\Rightarrow r \propto m^{1/3} \quad \dots (i)$$

From Eqs. (i) and (ii), we have

$$v \propto (m^{1/3})^2$$

$$\Rightarrow v \propto m^{2/3}$$

$$\Rightarrow \frac{v_2}{v_1} = \left(\frac{m_2}{m_1}\right)^{2/3}$$

$$= \left(\frac{64}{8}\right)^{2/3} = (8)^{2/3}$$

$$= (2^3)^{2/3} = 2^2 = 4$$

$$\Rightarrow v_2 = 4v_1 = 4 \times 3 = 12 \text{ cm}^3/\text{s}$$

Question5

If the excess pressures inside two soap bubbles are in the ratio 2 : 3, then the ratio of the volumes of the soap bubbles is

TG EAPCET 2024 (Online) 11th May Morning Shift

Options:

- A. 3 : 2
- B. 9 : 4
- C. 27 : 8
- D. 81 : 16

Answer: C

Solution:

Given,

$$\frac{p_1}{p_2} = \frac{2}{3}$$

We know that, the excess pressure inside a soap bubble is given by the formula

$$\Delta p = \frac{4Y}{r}$$

where, Δp = excess pressure, Y is the surface tension of the soap and r is the radius of the bubble.

Using Eq. (i), we can write

$$\frac{\frac{4Y}{r_1}}{\frac{4Y}{r_2}} = \frac{2}{3} \Rightarrow \frac{r_2}{r_1} = \frac{2}{3}$$

The ratio of the volumes of the soap bubble is

$$\frac{V_1}{V_2} = \frac{\frac{4}{3}\pi r_1^3}{\frac{4}{3}\pi r_2^3}$$

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

Using Eq. (ii), we get

$$\frac{V_1}{V_2} = \left(\frac{3}{2}\right)^3$$

$$V_1 : V_2 = 27 : 8$$

Question6

The velocities of air above and below the surfaces of a flying aeroplane wing are 50 ms^{-1} and 40 ms^{-1} , respectively. If the area of the wing is 10 m^2 and the mass of the aeroplane is 500 kg , then as time passes of (density of air = 13 kg m^{-3})

TG EAPCET 2024 (Online) 11th May Morning Shift

Options:

- A. the aeroplane will gain altitude
- B. the aeroplane will experience weightlessness
- C. the aeroplane will fly horizontally
- D. the aeroplane will loose altitude

Answer: A

Solution:

According to Bernouli's principle, the pressure difference between the top and bottom surfaces of the wing can be calculated as



$$p_{\text{bottom}} - p_{\text{top}} = \frac{1}{2} \rho (v_{\text{top}}^2 - v_{\text{bottom}}^2)$$

$$\text{Given, } \rho = 1.3 \text{ kg/m}^3, v_{\text{top}} = 50 \text{ m/s,}$$

$$v_{\text{bottom}} = 40 \text{ m/s}$$

After putting values,

$$\begin{aligned} p_{\text{bottom}} - p_{\text{top}} &= \frac{1}{2} \times 1.3 \times [(50)^2 - (40)^2] \\ &= \frac{1}{2} \times 1.3 \times 900 \\ &= 585 \text{ N/m}^2 \end{aligned}$$

The lift force is the pressure difference multiplied by the area of the wing.

$$\begin{aligned} F_{\text{lift}} &= (p_{\text{bottom}} - p_{\text{top}}) \cdot A \\ &= 585 \times 10 = 5850 \text{ N} \end{aligned}$$

The weight of the aeroplane,

$$w = mg = 500 \times 9.8 = 4900 \text{ N}$$

∴ Lift force is greater than the weight.

So, the net upward force is,

$$F_{\text{net}} = F_{\text{lift}} - w = 5850 - 4900 = 950 \text{ N}$$

Since the net force acting on the aeroplane is upward, the aeroplane will gain altitude.

Question7

Three identical vessels are filled up to the same height with three different liquids A , B and C of densities ρ_A , ρ_B and ρ_C , respectively. If $\rho_A > \rho_B > \rho_C$, then the pressure at the bottom of the vessels is

TG EAPCET 2024 (Online) 10th May Evening Shift

Options:

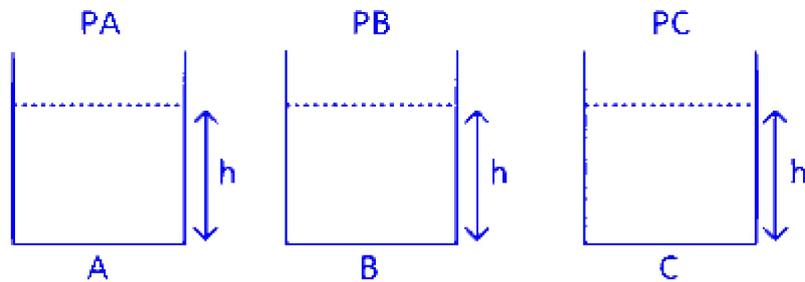
- A. equal in all vessels
- B. maximum in vessel containing liquid C
- C. maximum in vessel containing liquid B



D. maximum in vessel containing liquid A

Answer: D

Solution:



$\rho =$ density

$$\rho_A > \rho_B > \rho_C$$

We know the pressure and density is related as $p = \rho gh$

$$p_A = \rho_A gh, p_B = \rho_B gh, p_C = \rho_C gh$$

As g and h are constant.

$$\therefore p_A \propto \rho_A, p_B \propto \rho_B, p_C \propto \rho_C$$

$$\therefore p_A > p_B > p_C$$

Hence, vessel A has maximum pressure.

Question 8

A wooden cube of side 10 cm floats at the interface between water and oil with its lower surface 3 cm below the interface. If the density of oil is 0.9 g cm^{-3} , the mass of the wooden cube is

TG EAPCET 2024 (Online) 10th May Morning Shift

Options:

A. 940 g

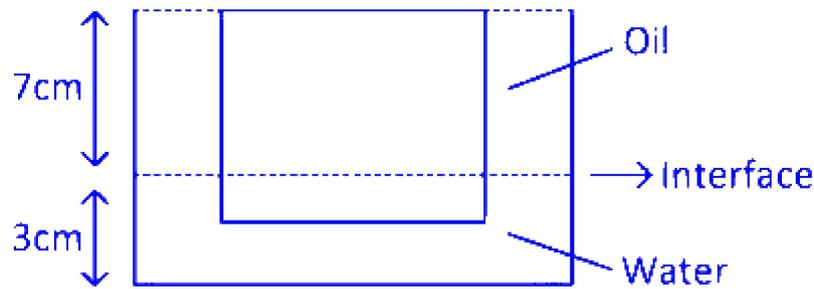
B. 900 g

C. 1000 g

D. 930 g

Answer: D

Solution:



Given,

$$\text{Oil density} = 0.9 \text{ g/cm}^3$$

$$\text{Water density} = 1 \text{ g/cm}^3$$

Weight of block = weight of oil displaced + weight of water displaced

Let m be mass of block

$$mg = (\text{Volume of water displaced} \times \text{Density of water} \times g) + (\text{Volume of oil displaced} \times \text{Density of oil} \times g)$$

$$m = 7 \times 10 \times 10 \times 0.9 + 3 \times 10 \times 10 \times 1$$

$$m = 630 + 300$$

$$m = 930 \text{ g}$$

Question9

The excess pressure inside a soap bubble of radius 0.5 cm is balanced by the pressure due to an oil column of height 4 mm . If the density of the oil is 900 kg m^{-3} , then the surface tension of the soap solution is (Acceleration due to gravity = 10 ms^{-2})

TG EAPCET 2024 (Online) 9th May Evening Shift

Options:

A. $9 \times 10^{-2} \text{ Nm}^{-1}$

B. $2.25 \times 10^{-2} \text{ Nm}^{-1}$

C. $4.5 \times 10^{-2} \text{ Nm}^{-1}$



D. $7 \times 10^{-2} \text{Nm}^{-1}$

Answer: C

Solution:

Given, radius of bubble, $r = 0.5 \text{ cm}$

$$= 0.5 \times 10^{-2} \text{ m}$$

Height of air column, $h = 4 \text{ mm}$

$$= 4 \times 10^{-3} \text{ m}$$

density of oil, $\rho = 900 \text{ kg m}^{-3}$

According to question;

Excess pressure in bubble

= Pressure due to air column

$$\frac{4S}{R} = \rho gh$$

$$\Rightarrow S = \frac{\rho ghR}{4}$$

$$= \frac{900 \times 10 \times 4 \times 10^{-3} \times 0.5 \times 10^{-2}}{4}$$

$$= 4.5 \times 10^{-2} \text{Nm}^{-1}$$

Question10

Water flows through a horizontal pipe of variable cross-section at the rate of 12π litre per minute. The velocity of the water at the point, where the diameter of the pipe becomes 2 cm is

TG EAPCET 2024 (Online) 9th May Evening Shift

Options:

A. 6 ms^{-1}

B. 8 ms^{-1}

C. 4 ms^{-1}



D. 2 ms^{-1}

Answer: D

Solution:

Given, Water flow rate = $12\pi \frac{\text{litre}}{\text{min}}$

$$= \frac{12\pi \times 10^{-3} \text{ m}^3}{1 \times 60 \text{ s}} = \frac{\pi}{5} \times 10^{-3} \text{ cm}^3/\text{s}$$

For one second; volume of water = $\pi r^2 h$

$$\Rightarrow \frac{\pi}{5} \times 10^{-3} \text{ m}^3 = \pi \left(\frac{d}{2}\right)^2 \times h$$

$$\Rightarrow \frac{10^{-3}}{5} \times \frac{1}{(1 \times 10^{-2})^2} = h \quad (\because d = 2 \text{ cm})$$

$$= \frac{10^{-3} \times 10^4}{5} = h$$

$$\Rightarrow h = 2 \text{ m}$$

$$\text{or velocity} = \frac{h \text{ m}}{1 \text{ s}} = 2 \text{ m/s}$$

Question11

**The height of water level in a tank of uniform cross-section is 5 m .
The volume of the water leaked in 5 s through a hole of area
 2.4 mm^2 made at the bottom of the tank is (Assume the level of the
water in the tank remains constant and acceleration due to gravity
 $= 10 \text{ ms}^{-2}$)**

TG EAPCET 2024 (Online) 9th May Morning Shift

Options:

A. $90 \times 10^{-6} \text{ m}^3$

B. $120 \times 10^{-6} \text{ m}^3$

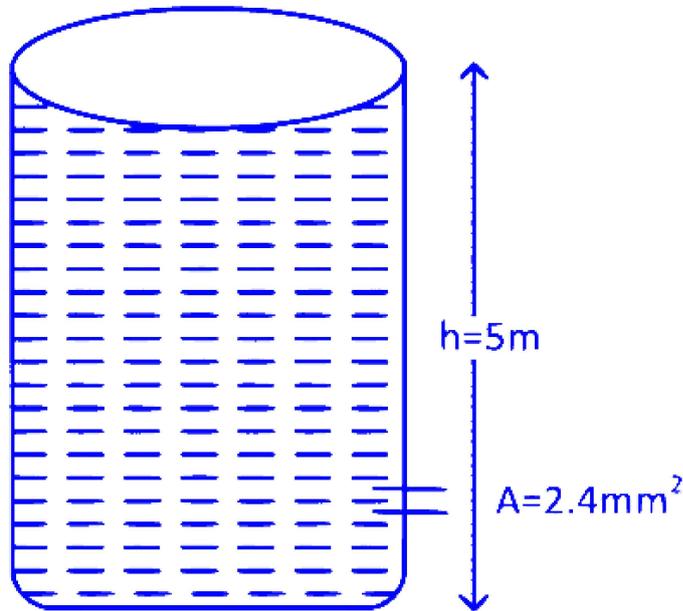
C. $80 \times 10^{-6} \text{ m}^3$



D. $40 \times 10^{-6} \text{ m}^3$

Answer: B

Solution:



Area of hole = 2.4 mm^2

Acceleration due to gravity = 10 m/s^2 To determine water leaked from tank,

Using formula, $v = \sqrt{2gh}$

$$v = \sqrt{2 \times 10 \times 5}$$

$$v = \sqrt{100} = 10 \text{ m/s} \quad \dots \text{ (i)}$$

Now, we can determine flow water (Q)

$$Q = v \times A \quad \dots \text{ (ii)}$$

$$A = 2.4 \text{ mm}^2$$

$$= 2.4 \times 10^{-6} \text{ m}^2$$

$$Q = 10 \times 2.4 \times 10^{-6}$$

$$= 2.4 \times 10^{-5} \text{ m}^3/\text{s}$$

Volume V leaked in 5 s ,



$$\begin{aligned}Q \times t &= 2.4 \times 10^{-5} \times 5 \\&= 1.2 \times 10^{-4} \text{ m}^3 \\&= 120 \times 10^{-6} \text{ m}^3\end{aligned}$$

Hence, the volume of the water leaked in 5 s through the hole is $120 \times 10^{-6} \text{ m}^3$.

Question12

If the work done in blowing a soap bubble of radius R is W , then the work done in blowing the soap bubble of radius $2R$ is

TS EAMCET 2023 (Online) 12th May Evening Shift

Options:

- A. $6 W$
- B. $12 W$
- C. $4 W$
- D. $2 W$

Answer: C

Solution:

To determine the work done in blowing a soap bubble, we consider the surface tension and the change in the surface area of the bubble.

Given:

Initial radius of the bubble = R

Work done to blow the initial bubble = W

New radius of the bubble = $2R$

The formula for the work done in blowing a soap bubble is:

$W = \text{Surface Tension} \times \text{Change in Area}$

Initial Case (Radius R)

For the initial bubble with radius R , the work done W is calculated as:

$$W_1 = (2T) \times 4\pi R^2 = 8\pi R^2 T$$

New Case (Radius $2R$)

For the bubble with a new radius $2R$, the work done W_2 is:

$$W_2 = (2T) \times 4\pi(2R)^2 = 32\pi R^2 T$$

Expressing W_2 in terms of W :

$$W_2 = 4(8\pi R^2 T) = 4W$$

Thus, the work done when the bubble is blown to a radius $2R$ is $4W$.

Question 13

Three identical vessels are filled with three liquids A, B and C with equal masses but having densities ρ_A, ρ_B and ρ_C respectively. If $\rho_A > \rho_B > \rho_C$ then the pressure at the bottom of the vessels will be

TS EAMCET 2023 (Online) 12th May Evening Shift

Options:

- A. equal in all vessels
- B. maximum in vessel containing liquid A
- C. maximum in vessel containing liquid B
- D. maximum in vessel containing liquid C

Answer: A

Solution:

Three identical vessels labeled A, B , and C are filled with different liquids that have equal masses but varying densities: ρ_A, ρ_B , and ρ_C , with the relationship $\rho_A > \rho_B > \rho_C$.

When the density is lower, the liquid occupies a greater volume, which means it will reach a higher height in the vessel, since the mass is constant across all vessels.

The volume of each liquid is given by:

$$\text{Volume}_A = \frac{m}{\rho_A},$$

$$\text{Volume}_B = \frac{m}{\rho_B},$$

$$\text{Volume}_C = \frac{m}{\rho_C}.$$

Given that the vessels have the same cross-sectional area a , the heights of the liquids in the vessels can be calculated as:

$$H_A = \frac{m}{a\rho_A},$$

$$H_B = \frac{m}{a\rho_B},$$

$$H_C = \frac{m}{a\rho_C}.$$

The pressure at the bottom of each vessel, determined by the pressure at a given depth, is calculated using:

$$p = \rho g H$$

Substituting for each vessel, we find:

$$p_A = \frac{(\rho_A g)m}{a\rho_A},$$

$$p_B = \frac{(\rho_B g)m}{a\rho_B},$$

$$p_C = \frac{(\rho_C g)m}{a\rho_C}.$$

Simplifying these expressions shows that:

$$p_A = p_B = p_C$$

Thus, the pressure at the bottom of the vessels is the same for each liquid, irrespective of the liquid's density.

Question 14

A straw of circular cross-section of radius R and negligible thickness is dipped vertically into a liquid of surface tension T . If the contact angle between the liquid and the straw material is 53° . The force acting on the straw due to surface tension of the liquid is
($\cos 53^\circ = 0.6$)

TS EAMCET 2023 (Online) 12th May Morning Shift

Options:

A. $\frac{12\pi RT}{5}$

B. $\frac{6\pi RT}{5}$

C. $\frac{4\pi RT}{5}$

D. $\frac{3\pi RT}{5}$

Answer: A

Solution:

Given:

Radius of the straw: R

Surface tension of the liquid: T

Contact angle: 53°

$$\cos 53^\circ = 0.6$$

The force due to surface tension is calculated using the formula:

$$F = T \times 2 \times (\text{length} + \text{thickness}) \times \cos \theta$$

Since the thickness is negligible, the formula simplifies to:

$$F = T \times 2 \times l \times \cos \theta$$

The length l of the contact line around the straw is the circumference of the straw's circular cross-section, which is $2\pi R$.

Thus, the force F becomes:

$$\begin{aligned} F &= T \times 2 \times 2\pi R \times \cos 53^\circ \\ &= T \times 4\pi R \times 0.6 \\ &= 2.4\pi RT \\ &= \frac{12\pi RT}{5} \end{aligned}$$

Hence, the force acting on the straw due to the surface tension of the liquid is $\frac{12\pi RT}{5}$.

Question15

A solid metal sphere released in a vertical liquid column has attained terminal velocity in the downward direction. The magnitudes of viscous force, buoyant force and gravitational force acting on it are F_V , F_B and F_W respectively. Then, the correct relation between them is



TS EAMCET 2023 (Online) 12th May Morning Shift

Options:

A. $F_B > F_V = F_W$

B. $F_W = F_V + F_B$

C. $F_B = F_W + F_V$

D. $F_V = F_B + F_W$

Answer: B

Solution:

When a solid metal sphere is released into a vertical liquid column and reaches terminal velocity, there is a balance of forces in play. The terminal velocity is the highest velocity achieved by an object as it falls through a fluid, at which point the net force acting on it is zero, and it stops accelerating.

In this scenario:

F_B : Buoyant force, acts upward.

F_V : Viscous force, acts upward, resisting motion.

F_W : Gravitational force, acts downward.

Since the object has reached terminal velocity, the sum of the upward forces (buoyant and viscous) equals the downward gravitational force. Hence, the correct relationship between these forces is:

$$F_W = F_B + F_V$$

This equation indicates that the gravitational force acting downward is balanced by the buoyant force and the viscous force, both acting upward.

