PRAYAS

JEE 2025

Fluid (KPP)

KPP

Physics

Mechanical Properties of Fluids

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Question 1

An ideal fluid flows (laminar flow) through a pipe of non-uniform diameter. The maximum and minimum diameters of the pipes are 6.4 *cm* and 4.8 *cm*, respectively. The ratio of the minimum and the maximum velocities of fluid in this pipe is:

(JEE Mains 2020)

$Av \rightarrow \text{const}$

$$\frac{v_{max}}{v_{min}} = \left(\frac{\gamma_{min}}{\gamma_{max}}\right)^2$$

$$\left(\frac{24}{32}\right)^2 = \left(\frac{3}{4}\right)^2$$

A $\frac{\sqrt{3}}{2}$

B $\frac{3}{4}$

C $\frac{81}{256}$

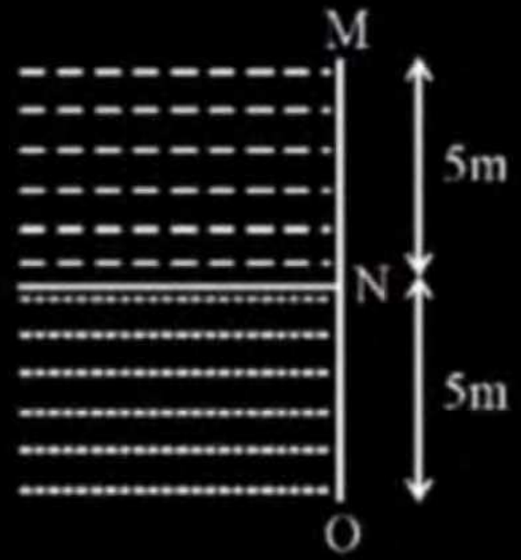
D $\frac{9}{16}$

Ans. (D)

Question 2

Two liquids of densities ρ_1 and ρ_2 ($\rho_2 = 2\rho_1$) are filled up behind a square wall of side 10 m as shown in figure. Each liquid has a height of 5 m. The ratio of the forces due to these liquids exerted on upper part MN to that at the lower part NO is (Assume that the liquids are not mixing)

(JEE Mains 2020)



A) 1/4

B) 2/3

C) 1/3

D) 1/2

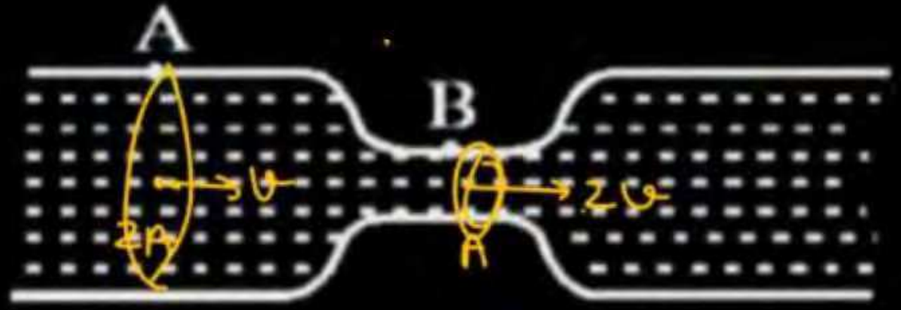
Ans. (A)

Question 3

Water flows in a horizontal tube (see figure). The pressure of water changes by $700 Nm^{-2}$ between A and B where the area of cross section are $40\ cm^2$ and $20\ cm^2$, respectively. Find the rate of flow of water through the tube.

(density of water $= 1000 kgm^{-3}$).

(JEE Mains 2020)



(A) $1810\ cm^3/s$

(B) $3020\ cm^3/s$

(C) $2720\ cm^3/s$

(D) $2420\ cm^3/s$

Ans. (C)

Question 4

A cylindrical vessel containing a liquid is rotated about its axis so that the liquid rises at its sides as shown in the figure. The radius of vessel is 5 cm and the angular speed of rotation is ω rad s^{-1}. The difference in the height, h(in cm) of liquid at the centre of vessel and at the side will be:

(JEE Mains 2020)

(A) $\frac{25\omega^2}{2g}$

(B) $\frac{2\omega^2}{5g}$

(C) $\frac{5\omega^2}{2g}$

(D) $\frac{2\omega^2}{25g}$

Ans. (A)

Question 5

A fluid is flowing through a horizontal pipe of varying cross-section, with speed $v\ ms^{-1}$ at a point where the pressure is P Pascal. At another point where pressure is $\frac{P}{2}$ Pascal its speed is $V\ ms^{-1}$. If the density of the fluid is $\rho\ kg\ m^{-3}$ and the flow is streamline, then V is equal to:

(JEE Mains 2020)

(A) $\sqrt{\frac{P}{2\rho} + v^2}$

(B) $\sqrt{\frac{P}{\rho} + v^2}$

(C) $\sqrt{\frac{2P}{\rho} + v^2}$

(D) $\sqrt{\frac{P}{\rho} + v}$

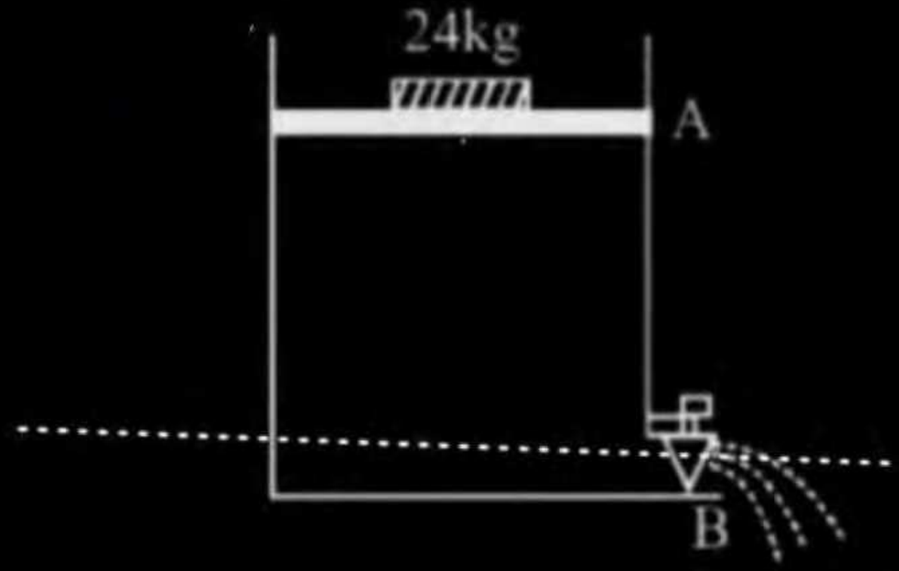
Ans. (B)

Question 6

Consider a water tank as shown in the figure. It's cross-sectional area is $0.4\ m^2$. The tank has an opening B near the bottom whose cross-section area is $1\ cm^2$. A load of 24 kg is applied on the water at the top when the height of the water level is 40 cm above the bottom, the velocity of water coming out the opening B is v ms^{-1}. The value of v, to the nearest integer, is .

[Take value of g to be 10 ms^{-2}]

(JEE Mains 2021)

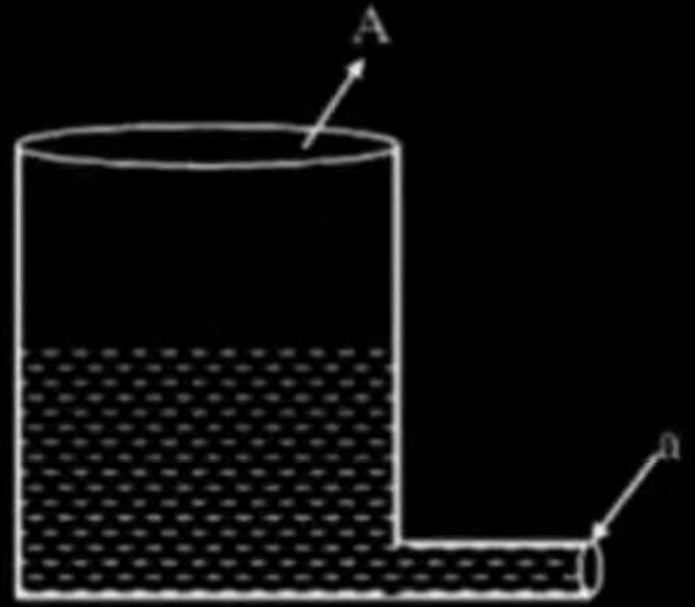


Ans. (3)

Question 7

A light cylindrical vessel is kept on a horizontal surface. Area of base is A. A hole of cross-sectional area 'a' is made just at its bottom side. The minimum coefficient of friction necessary to prevent sliding the vessel due to the impact force of the emerging liquid is $(a << A)$:

(JEE Mains 2021)



(A) $\frac{A}{2a}$

(B) None of these

(C) $\frac{2a}{a}$

(D) $\frac{a}{A}$

Ans. (C)

Question 8

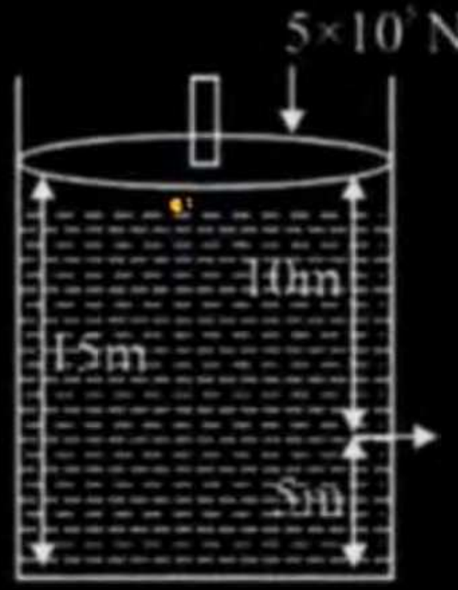
Consider a cylindrical tank of radius 1 m is filled with water. The top surface of water is at 15 m from the bottom of the cylinder. There is a hole on the wall of cylinder at a height of 5 m from the bottom. A force of 5×10^5 N is applied an the top surface of water using a piston. The speed of efflux from the hole will be:
(given atmospheric pressure $P_A = 1.01 \times 10^5\ Pa$, density of water $\rho_W = 1000\ \text{kg/m}^3$ and gravitational acceleration $g = 10\ \text{m/s}^2$) **(JEE Mains 2022)**

(A) 11.6 m/s

(B) 10.8 m/s

(C) 17.8 m/s

(D) 14.4 m/s



Ans. (C)

Question (9)

An ideal fluid of density 800kgm^{-3}, flows smoothly through a bent pipe (as shown in figure) That tapers in cross-m sectional area from a to $\frac{a}{2}$. The pressure difference between the wide and narrow section of pipe is 4100 Pa. At wider section, the velocity of fluid is $\frac{\sqrt{x}}{6}\text{ms}^{-1}$ for $x =$ _____. (Given $g = 10\ \text{m}^{-2}$) **(JEE Mains 2022)**

Ans. (363)

Question 10

The area of cross-section of a large tank is $0.5\ m^2$. It has a narrow opening near the bottom having area of cross-section $1\ cm^2$ A load of 25 kg is applied on the water at the top in the tank. Neglecting the speed of water in the tank, the velocity of the water, coming out of the opening at the time when the height of water level in the tank is 40 cm above the bottom, will be _____cm^{-1}. [Take $g = 10\ ms^{-2}$] **(JEE Mains 2022)**

Ans. (300)

Question 11

A hydraulic automobile lift is designed to lift vehicles of mass 5000 kg. The area of cross section of the cylinder carrying load is 250 cm^2. The maximum pressure the smaller piston would have to bear is _____. [Assume $g = 10\ m\ s^{-2}$]

(08 April 2023 - Shift 2)

A 20×10^6 Pa

B 2×10^5 Pa

C 200×10^6 Pa

D 2×10^6 Pa

Ans. (D)

Question 12

Given below are two statements:

Statement I: Pressure in a reservoir of water is same at all points at the same level of water.

Statement II: The pressure applied to enclosed water is transmitted in all directions equally.

In the light of the above statements, choose the correct answer from the options given below:

(10 April 2023 - Shift 1)

(A) Both Statement I and Statement II are false

(B) Statement I is true but Statement II is false

(C) Statement I is false but Statement II is true

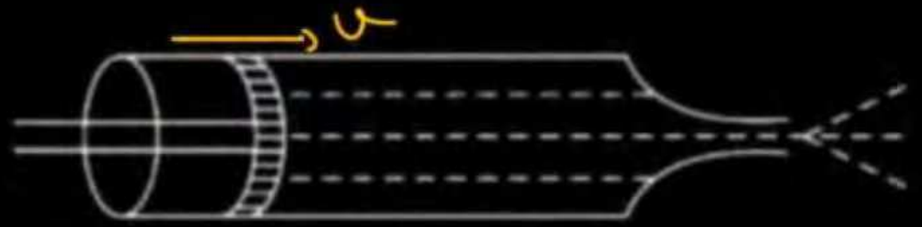
(D) Both Statement I and Statement II are true

Ans. (D)

Question 13

Figure below shows a liquid being pushed out of the tube by a piston having area of cross section 2.0 cm^2. The area of cross section at the outlet is 10 mm^2. If the piston is pushed at a speed of 4 cm s^{-1}, the speed of outgoing fluid is _____ .cm s^{-1}

(10 April 2023 - Shift 2)

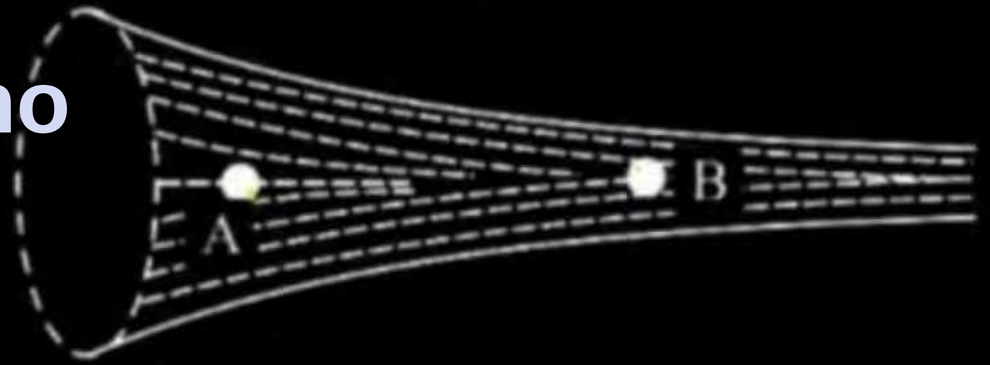


Ans. (80)

Question 14

The figure shows a liquid of given density flowing steadily in horizontal tube of varying cross-section. Cross-sectional areas at A is 1.5 cm^2, and B is 25 mm^2, if the speed of liquid at B is 60 cm s^{-1} then $(P_A - P_B)$ is _____.
(Given P_A and P_B are liquid pressures at A and B points. Density ρ = 1000 kg m^{-3}
A and B are on the axis of tube)

(13 April 2023 - Shift 1)



(A) 135 Pa

(B) 27 Pa

(C) 175 Pa

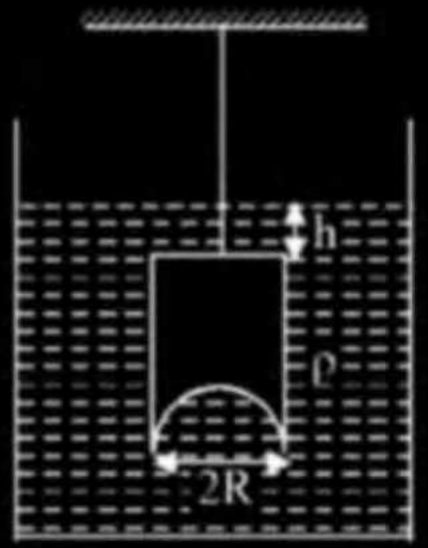
(D) 36 Pa

Ans. (C)

Question 157

A hemispherical portion of radius R is removed from the bottom of a cylinder of radius R. The volume of the remaining cylinder is V and its mass M. It is suspended by a string in a liquid of density ρ where it stays vertical. The upper surface of the cylinder is at a depth h below the liquid surface. The force on the bottom of the cylinder by the liquid is :

1. Mg
2. $Mg - V\rho g$
3. $Mg + \pi R^2 h\rho g$
4. $\rho g(V + \pi R^2 h)$



Ans. (4)

Question 16

A U-tube of uniform cross section (see Fig) is partially filled with a liquid I. Another liquid II which does not mix with liquid I is poured into one side. It is found that the liquid levels of the two sides of the tube are the same, while the level of liquid I has risen by 2 cm. If the specific gravity of liquid I is 1.1, the specific gravity of liquid II must be:

1. 1.12
2. 1.1
3. 1.05
4. 1.0

Ans. (2)

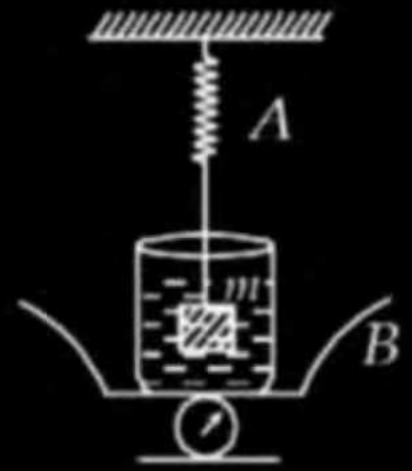
Question 17

A solid sphere of radius R made of a material of bulk modulus K is surrounded by a liquid in a cylindrical container. A massless piston of area A floats on the surface of the liquid. When a mass M is placed on the piston to compress the liquid the fractional change in the radius of the sphere, $\delta SR/R$, is_____

Ans. $(Mg/3Ak)$

Question 18

The spring balance A reads 2 kg with a block m suspended from it. A balance Breads 5 kg when a beaker with liquid is put on the pan of the balance. The two balances are now so arranged that the hanging mass is inside the liquid in the beaker as shown in the figure. In this situation:

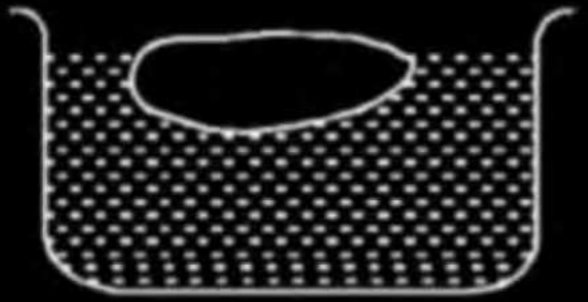


1. The balance A will read more than 2 kg
2. The balance B will read more than 5 kg
3. The balance A will read less than 2 kg and B will read more than 5k g
4. The balance A and B will read 2kg and 5 kg respectively.

Ans. (2, 3)

Question 19

A body floats in a liquid contained in a beaker. The whole system as shown in Figure falls freely under gravity. The up thrust on the body is/are:



1. Zero
2. equal to the weight of the liquid displaced
3. equal to the weight of the body in air
4. equal to the weight of the immersed portion of the body

Ans. (1)

Question 20

Water from a tap emerges vertically downwards with an initial speed of 1.0 m s^{-1}. The cross-sectional area of the tap is 10 m^2. Assume that the pressure is constant throughout the stream of water, and that the flow is steady. The cross-sectional area of the stream 0.15 m below the tap is:

1. 5.0×10^{-4} m^2
2. 1.0×10^{-5} m^2
3. 5.0×10^{-5} m^2
4. 2.0×10^{-5} m^2

Ans. (3)

Question (21)

A horizontal pipeline carries water in a streamline flow. At a point along the pipe, where the cross-sectional area is 10 cm^2, the water velocity is 1 ms^{-1} and the pressure is 2000 Pa. The pressure of water at another point where the cross-sectional area is 5 cm^2, is... Pa. (Density of water = 10^3 $kg.m^{-3}$)

Ans. (500)

Question 22

Statement-1: The stream of water flowing at high speed from a garden hose pipe tends to spread like a fountain when held vertically up, but tends to narrow down when held vertically down.

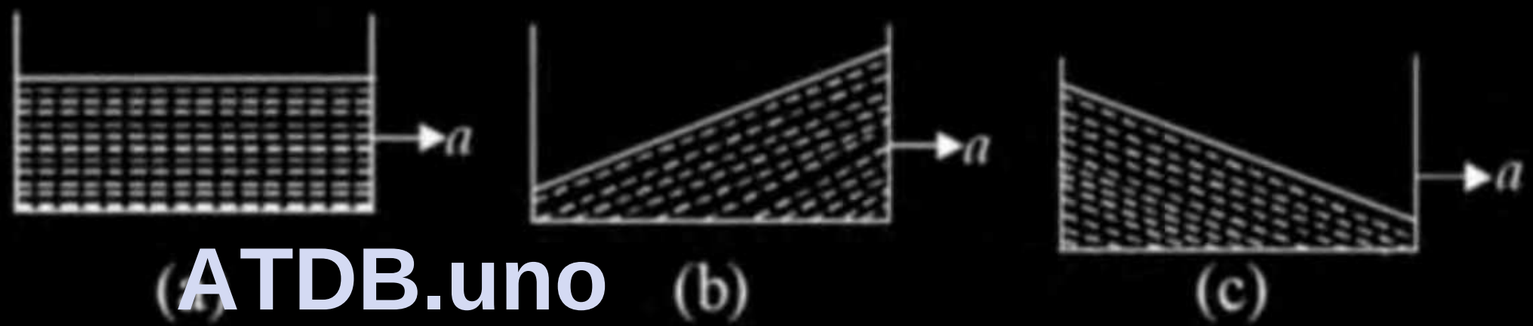
Statement-2: In any steady flow of an incompressible fluid, the volume flow rate of the fluid remains constant.

1. Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1
2. Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1
3. Statement-1 is True, Statement-2 is False
4. Statement-1 is False, Statement-2 is True

Ans. (1)

Question 23

A vessel containing water is given a constant acceleration 'a' towards the right along a straight horizontal path. Which of the following diagrams in Fig. represents the surface of the liquid ?



(a) (b) (c)

Ans. (3)

Question 24

A person in lift is holding a water jar, which has a small hole at the lower end of its side. When the lift is at rest, the water jet coming out of the hole hits the floor of the lift at a distance d of 1.2 m from the person. In the following, state of the lift's motion is given in List-I and the distance where the water jet hits the floor of the lift is given in List-II. Match the statements from List-I with those in List-II and select the correct answer using the code given below the lists.

List - I	List - II
Lift is accelerating vertically up	1. $d = 1.2\ n$
Lift is accelerating vertically down with an acceleration less than the gravitational acceleration	2. $d > 1.2\ n$
Lift is moving vertically up with constant speed	3. $d < 1.2\ m$
Lift is falling freely	4. No water leaks out of the jar

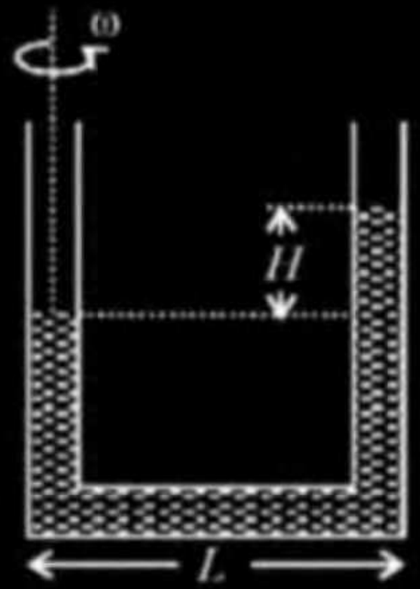
Codes :

1. P-2, Q-3, R-2, S-4
2. P-2, Q-3, R-1, S-4
3. P-1, Q-1, R-1, S-4
4. P-2, Q-3, R-1, S-1

Ans. (3)

Question 25

A U tube is rotated about one of it's limbs with an angular velocity. Find the difference in height H of the liquid (density p) level, where diameter of the tube $d << L$.



Question 26

A cubical block of side 0.5 m floats on water with 30% of its volume under water. What is the maximum weight that can be put on the block without fully submerging it under water ? [Take, density of water = 10^3 kg/m^3] **(JEE Mains 2019)**

1. 46.3 kg
2. 87.5 kg
3. 65.4 kg
4. 30.1 kg

Ans. (2)

Question 27

Water from a tap emerges vertically downwards with an initial speed of $1.0 ms^{-1}$. The cross-sectional area of the tap is 10^{-4} m^2 Assume that the pressure is constant throughout the stream of water and that the flow is streamlined. The cross-sectional area of the stream, 0.15 m below the tap would be: [Take g= 10 ms^{-2})

(JEE Mains 2019)

1. 2×10^{-5} m^2
2. 5×10^{-5} m^2
3. 5×10^{-4} m^2
4. 1×10^{-5} m^2

Ans. (2)

Question 28

The water is filled upto height of 12 m in a tank having vertical sidewalls. A hole is made in one of the walls at a depth 'h' below the water level. The value of 'h' for which the emerging stream of water strikes the ground at the maximum range is _____m.

(JEE Mains 2021)

Ans. (6)

Question 29

A hydraulic press can lift 100 kg when a mass 'm' is placed on the smaller piston. It can lift _____kg when the diameter of the larger piston is increased by 4 times and that of the smaller piston is decreased by 4 times keeping the same mass 'm' on the smaller piston.

(JEE Mains 2021)

Ans. (25600)

Question 30

A raindrop with radius R = 0.2 mm falls from a cloud at a height h = 2000 m above the ground. Assume that the drop is spherical throughout its fall and the force of buoyance may be neglected, then the terminal speed attained by the raindrop is:

[Density of water $fw = 1000\ \text{kg m}^{-3}$ and Density of air $fa = 1.2\ \text{kg m}^{-3}$, $g = 10\ \text{m/s}^2$, Coefficient of viscosity of air $= 1.8 \times 10^{-5}\ \text{Nsm}^{-2}$]

(JEE Mains 2021)

(A) $250.6\ \text{ms}^{-1}$

(B) $43.56\ \text{ms}^{-1}$

(C) $4.94\ \text{ms}^{-1}$

(D) $14.4\ \text{ms}^{-1}$

Ans. (C)

Question 3

The diameter of an air bubble which was initially 2 mm, rises steadily through a solution of density 1750 kg m^{-3} at the rate of 0.35 cm s^{-1}. The coefficient of viscosity of the solution is ____ poise (in nearest integer).
(the density of air is negligible).

(JEE Mains 2022)

Ans. (11)

Question 32

The velocity of a small ball of mass 0.3 g and density 8 g/cc when dropped in a container filled with glycerine becomes constant after some time. If the density of glycerine is 1.3 g/cc, then the value of viscous force acting on the ball will be $x \times 10^{-4}$ N, the value of x is _____. [use $g = 10\ m/s^2$]

(JEE Mains 2022)

Ans. (25)

Question 33

In an experiment to verify Stokes law, a small spherical ball of radius r and density ρ falls under gravity through a distance h in air before entering a tank of water. If the terminal velocity of the ball inside water is same as its velocity just before entering the water surface, then the value of h is proportional to: (ignore viscosity of air)

(JEE Mains 2020)

A r

B r^4

C r^3

D r^2

Ans. (B)

Question 34

The terminal velocity (v_t) of the spherical rain drop depends on the radius (r) of the spherical rain drops as :

(JEE Mains 2022)

A $r^{1/2}$

B r

C r^2

D r^3

Ans. (C)

Question 35

The velocity of upper layer of water in a river is $36 kmh^{-1}$. Shearing stress between horizontal layers of water is $10^{-3} Nm^{-2}$. Depth of the river is _____m.
(Cp-efficiency of viscosity of water is 10^{-2} Pa.s)

(JEE Mains 2022)

Ans. (100)

Question 36

The velocity of a small ball of mass 'm' and density d_1, when dropped in a container filled with glycerine, becomes constant after some time. If the density of glycerine is d_2, then the viscous force acting on the ball, will be : **(JEE Mains 2022)**

(A) $mg\left(1-\frac{d_1}{d_2}\right)$

(B) $mg\left(1-\frac{d_2}{d_1}\right)$

(C) $mg\left(\frac{d_1}{d_2}-1\right)$

(D) $mg\left(\frac{d_2}{d_1}-1\right)$

Ans. (B)

Question 37

When a ball dropped into a lake from a height 4.9 m above the water level, it hits the water with a velocity v and then sinks to the bottom with the constant velocity v. It reaches the bottom of the lake 4.0 s after it is dropped. The approximate depth of the lake is :

(JEE Mains 2022)

(A) 19.6 m

(B) 29.4 m

(C) 39.2 m

(D) 73.5 m

Ans. (B)

Question 36

A liquid of density 750kg m^{-3} flows smoothly through a horizontal pipe that tapers in cross-sectional area from $A_1 = 1.2 \times 10^{-2} m^2$ to $A_2 = \frac{A_1}{2}$. The pressure difference between the wide and narrow sections of the pipe is 4500 Pa. The rate of flow of liquid is _____ $\times 10^{-3}$ m^3 s^{-1}.

(JEE Mains 2022)

Ans. (25)

Question 39

A small density of ball of radius 0.1 mm and density 10^4 kg m^{-3} falls freely under gravity through a distance h before entering a tank of Water. If after entering the water the velocity of ball does not change and it continues to fall with same constant velocity inside water, then the value of h will be _____m. (Given $g = 10\ ms^{-2}$, viscosity of water $= 1.0 \times 10^{-5}\ N - sm^{-2}$). **(JEE Mains 2022)**

Ans. (20)

Question 40

A Spherical ball of radius 1 mm and density 10.5 g/cc is dropped in glycerine of coefficient of viscosity 9.8 poise and density 1.5 g/cc. Viscous force on the ball when it attains constant velocity is 3696×10^{-x} N. The value of x is _____.

(Given, $g = 9.8\ m/s^2$ and $\pi = \frac{22}{7}$)

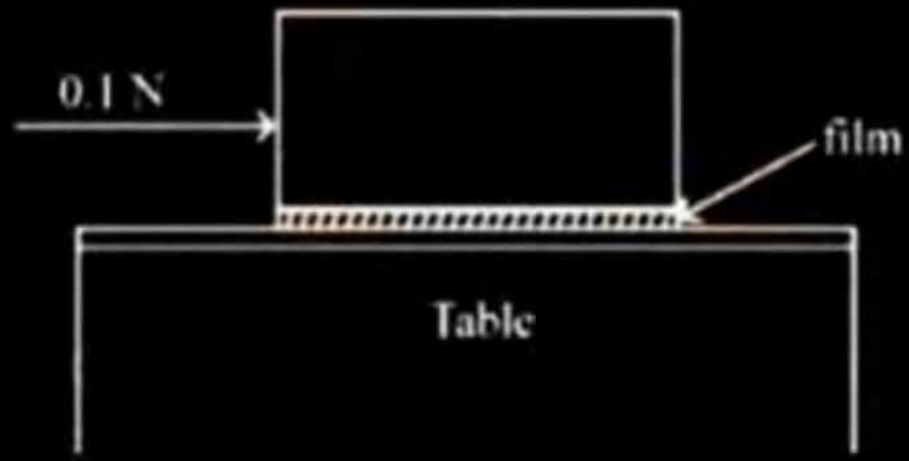
(24 January 2023 - Shift 2)

Ans. (7)

Question 41

A metal block of base area $0.20\ m^2$ is placed on a table, as shown in figure. A liquid film of thickness 0.25 mm is inserted between the block and the table. The block is pushed by a horizontal force of 0.1 N and moves with a constant speed. If the viscosity of the liquid is 5.0×10^{-3} Pl, the speed of block is $\times 10^{-3}$ m/s.

(29 January 2023 - Shift 2)



Ans. (25)

Question 42

The surface of water in a water tank of cross section area 750 cm^2 on the top of a house is h m. above the tap level. The speed of water coming out through the tap of cross section area 500 mm^2 is 30 cm/s. At that instant, $\frac{dh}{dt}$ is $x \times 10^{-3}$ m/s. The value of x will be

(01 February 2023 - Shift 1)

Ans. (2)

Question 43

A small ball of mass M and density ρ is dropped in a viscous liquid of density ρ_0. After some time, the ball falls with a constant velocity. What is the viscous force on the ball?

(06 April 2023 - Shift 1)

A $F = Mg\left(1 + \frac{\rho_0}{\rho}\right)$

B $F = Mg\left(1 + \frac{\rho}{\rho_0}\right)$

C $F = Mg\left(1 - \frac{\rho_0}{\rho}\right)$

D $F = Mg(1 \pm \rho\rho_0)$

Ans. (C)

Question 44

Eight equal drops of water are falling through air with a steady speed of $10\ cm\ s^{-1}$. If the drops coalesce, the new velocity is: **(11 April 2023 - Shift 2)**

(A) $16\ cm\ s^{-1}$

(B) $40\ cm\ s^{-1}$

(C) $5\ cm\ s^{-1}$

(D) $10\ cm\ s^{-1}$

Ans. (B)

Question 45

A capillary tube made of glass of radius 0.15 mm is dipped vertically in a beaker filled with methylene iodide (surface tension = 0.05 Nm^{-1}, density = 667 kg m^{-3}) which rises to height h in the tube. It is observed that the two tangents drawn from liquid-glass interfaces (from opp. sides of the capillary) make an angle of 60° with one another. Then h is close to (g = 10 ms^{-2}). **(JEE Mains 2020)**

(A) 0.137 m

(B) 0.172 m

(C) 0.087 m

(D) 0.049 m

Ans. (C)

Question 46

Pressure inside two soap bubbles are 1.01 and 1.02 atmosphere, respectively. The ratio of their volumes is:

(JEE Mains 2020)

(A) 8 : 1

(B) 0.8 : 1

(C) 2 : 1

(D) 4 : 1

Ans. (A)

Question 47

When a long glass capillary tube of radius 0.015 cm is dipped in a liquid, the liquid rises to a height of 15 cm within it. If the contact angle between the liquid and glass to close to 0°, the surface tension of the liquid, in milli Newton m^{-1}, is $[\rho_{(liquid)} = 900\ kg\ m^{-3}, g = 10\ ms^{-2}]$ (Give answer in closest integer)_____.

(JEE Mains 2020)

$$h = \frac{2S\cos\theta}{r\rho g}$$

$$S = \frac{h r \rho g}{2\cos\theta} =$$

Ans. (101)

Question 48

A hollow spherical shell at outer radius R floats just submerged under the water surface. The inner radius of the shell is r. If the specific gravity of the shell material is $\frac{27}{8}$ w.r.t. water, the value of r is:

(JEE Mains 2020)

(A) $\frac{4}{9}R$

(B) $\frac{8}{9}R$

(C) $\frac{1}{3}R$

(D) $\frac{2}{3}R$

Ans. (B)

Question 49

What will be the nature of flow of water from a circular tap, when its flow rate increased from 0.18 L/min to 0.48 L/min ? The radius of the tap and viscosity of water are 0.5 cm and 10^{-3} Pa s, respectively. (Density of water: 10^3 kg/m^3)

(JEE Mains 2021)

(A) Unsteady to steady flow

(B) Remains steady flow

(C) Remains turbulent flow

(D) Steady flow to unsteady flow

Ans. (D)

Question 50

When two soap bubbles of radii a and b (b > a) coalesce, the radius of curvature of common surface is:

(JEE Mains 2021)

(A) $\frac{ab}{b-a}$

(B) $\frac{a+b}{ab}$

(C) $\frac{b-a}{ab}$

(D) $\frac{ab}{a+b}$

Ans. (A)

Question 51

Two small drops of mercury each of radius R coalesce to form a single large drop. The ratio of total surface energy before and after the change is: (JEE Mains 2021)

(A) $2^{\frac{1}{2}} : 1$

(B) $1 : 2^{\frac{1}{3}}$

(C) $2 : 1$

(D) $1 : 2$

Ans. (A)

Question 52

Two spherical soap bubbles of radii r_1 and r_2 in vacuum combine under isothermal conditions. The resulting bubble has a radius equal to: **(JEE Mains 2021)**

A $\frac{r_1 r_2}{r_1 + r_2}$

B $\sqrt{r_1 r_2}$

C $\sqrt{r_1^2 + r_2^2}$

D $\frac{r_1 + r_2}{2}$

Ans. (C)

Question 53

Two narrow bores of diameter 5.0 mm and 8.0 mm are joined together to form a U-shaped tube open at both ends. If this U-tube contains water, what is the difference in the level of two limbs of the tube.

[Take surface tension of water $T = 7.3 \times 10^{-2}$ Nm^{-1}, angle of contact = 0, $g = 10$ ms^{-2} and density of water = 1.0×10^{3} kg m^{-3}]

(JEE Mains 2021)

(A) 3.62 mm

(B) 2.19 mm

(C) 5.34 mm

(D) 4.97 mm

Ans. (B)

Question

54

A drop of liquid of density ρ is floating half immersed in a liquid of density σ and surface tension 7.5×10^{-4} Ncm^{-1}. The radius of drop in cm will be : (Take : g = 10 m/s^2)

(JEE Mains 2022)

A $\frac{15}{\sqrt{2\rho-\sigma}}$

B $\frac{15}{\sqrt{\rho-\sigma}}$

C $\frac{3}{2\sqrt{\rho-\sigma}}$

D $\frac{3}{20\sqrt{2\rho-\sigma}}$

Ans. (A)

Question 55

A water drop of radius 1 cm is broken into 729 equal droplets. If surface tension of water is 75 dyne/cm, then the gain in surface energy upto first decimal place will be:
[Given $\pi = 3.14$]

(JEE Mains 2022)

(A) 8.5×10^{-4}J

(B) 8.2×10^{-4}J

(C) 7.5×10^{-4}J

(D) 5.3×10^{-4}J

Ans. (C)

Question

56

A spherical soap bubble of radius 3 cm is formed inside another spherical soap bubble of radius 6 cm. If the internal pressure of the smaller bubble of radius 3 cm in the above system is equal to the internal pressure of the another single soap bubble of radius r cm. The value of r is _____.

(JEE Mains 2022)

Ans. (2)

Question

57

A pressure-pump has a horizontal tube of cross-sectional area $10\ cm^2$ for the outflow of water at a speed of 20 m/s. The force exerted on the vertical wall just in front of the tube which stops water horizontally flowing out of the tube, is:[given : density of water $= 1000\ kg/m^3$]

(JEE Mains 2022)

(A) 300 N

(B) 500 N

(C) 250 N

(D) 400 N

Ans. (D)

Question

58

If ρ is the density and η is coefficient of viscosity of fluid which flows with a speed v in the pipe of diameter d, the correct formula for Reynolds number R_e is :

(JEE Mains 2022)

A $R_e = \frac{\eta d}{\rho v}$

B $R_e = \frac{\rho v}{\eta d}$

C $R_e = \frac{\rho v d}{\eta}$

D $R_e = \frac{\eta}{\rho v d}$

Ans. (C)

Question

59

A water droplet of diameter 2 cm is broken into 64 equal droplets. The surface tension of water is 0.075 N/m. In this [process the gain in surface energy will be:

(JEE Mains 2022)

(A) 2.8×10^{-4} J

(B) 1.5×10^{-3} J

(C) 1.9×10^{-4} J

(D) 9.4×10^{-5} J

Ans. (A)

Question 60

A spherical drop of liquid splits into 1000 identical spherical drops. If u_i is the surface energy of the original drop and u_f is the total surface energy of the resulting drops, the (ignoring evaporation). $\frac{u_f}{u_i} = \left(\frac{10}{x}\right)$. Then value of x is _____.

(25 January 2023 - Shift 2)

Ans. (1)

Question

61

Surface tension of a soap bubble is 2.0×10^{-2} Nm^{-1}. Work done to increase the radius of soap bubble from 3.5 cm to 7 cm will be : [Take $\pi = \frac{22}{7}$]

(29 January 2023 - Shift 1)

A 0.72×10^{-4} J

B 5.76×10^{-4} J

C 18.48×10^{-4} J

D 9.24×10^{-4} J

Ans. (C)

Question

62

The height of liquid column raised in a capillary tube of certain radius when dipped in liquid A vertically is, 5 cm. If the tube is dipped in a similar manner in another liquid B of surface tension and density double the values of liquid A, the height of liquid column raised in liquid B would be

(30 January 2023 - Shift 1)

$h = 5 = \frac{2S\cos\theta}{\rho g}$

(A) 0.20 m

(B) 0.5 m

(C) 0.05 m

(D) 0.10 m

Ans. (C)

Question 63

If 1000 droplets of water of surface tension 0.07 N/m. having same radius 1 mm each, combine to from a single drop. In the process the released surface energy is(Take $\pi = \frac{22}{7}$)

(31 January 2023 - Shift 1)

A 7.92×10^{-6} J

B 7.92×10^{-4} J

C 9.68×10^{-4} J

D 8.8×10^{-5} J

Ans. (B)

Question

64

A mercury drop of radius 10^{-3} m is broken into 125 equal size droplets. Surface tension of mercury is 0.45 Nm^{-1}. The gain in surface energy is:

(01 February 2023 - Shift 1)

A 2.26×10^{-5} J

B 28×10^{-5} J

C 17.5×10^{-5} J

D 5×10^{-5} J

Ans. (A)

Question

65

An air bubble of volume 1 cm^3 rises from the bottom of a lake 40 m deep to the surface at a temperature of 12°C. The atmospheric pressure is 1×10^5 Pa, the density of water is 1000 kg m^{-3} and g = 10 m s^{-2}. There is no difference of the temperature of water at the depth of 40 m and on the surface. The volume of air bubble when it reaches the surface will be _____. **(08 April 2023 - Shift 1)**

(A) 2 cm^3

(B) 3 cm^3

(C) 4 cm^3

(D) 5 cm^3

Ans. (D)

Question 66

An air bubble of diameter 6 mm rises steadily through a solution of density 1750 kg m^{-3} at the rate of 0.35 cm s^{-1}. The co-efficient of viscosity of the solution (neglect density of air) is _____Pas (given, g = 10 m s^{-2}). **(08 April 2023 - Shift 1)**

Ans. (10)

Question

67

The surface tension of soap solution is 3.5×10^{-2} N m^{-1}. The amount of work done required to increase the radius of soap bubble from 10 cm to 20 cm is _____ $\times 10^{-4}$ J. (take $\pi = \frac{22}{7}$)

(11 April 2023 - Shift 2)

Ans. (264)

Question

68

64 identical drops each charged upto potential of 10mV are combined to form a bigger drop. The potential of the bigger drop will be _____mV.

(12 April 2023 - Shift 1)

Ans. (160)

Question 69

There is an air bubble of radius 1.0 mm in a liquid of surface tension 0.075 N m^{-1} and density 1000 kg m^{-3} at a depth of 10 cm below the free surface. The amount by which the pressure inside the bubble is greater than the atmospheric pressure is _____Pa. ($g = 10\ m\ s^{-2}$).

(15 April 2023 - Shift 1)

Ans. (1150)

1. A spherical solid ball of volume V is made of a material of density ρ_1. It is falling through a liquid of density $\rho_2\,(\rho_2 < \rho_1)$. Assume that the liquid applies a viscous force on the ball that is propoertional to the square of its speed v, i.e., $F_{viscous} = -kv^2\,(k > 0)$. Then terminal speed of the ball is **[AIEEE - 2008]**

70

(1*) $\sqrt{\dfrac{Vg(\rho_1 - \rho_2)}{k}}$ (2) $\dfrac{Vg\rho_1}{k}$ (3) $\sqrt{\dfrac{Vg\rho_1}{k}}$ (4) $\dfrac{Vg(\rho_1 - \rho_2)}{k}$

Ans. (1)

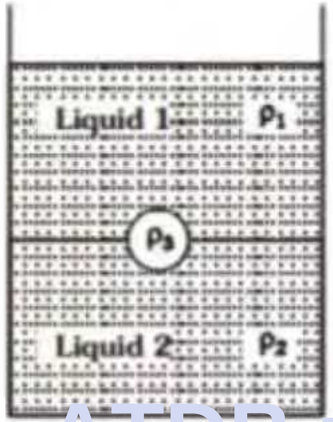
2. A jar is filled with two non-mixing liqudis 1 and 2 having densities ρ_1 and ρ_2, respectively. A solid ball, made of a material of density ρ_3, is dropped in the jar. It comes to equilibrium in the position shown in the figure. Which of the following is true for ρ_1, ρ_2 and ρ_3 **[AIEEE - 2008]**

(1) $\rho_3 < \rho_1 < \rho_2$

(2) $\rho_1 > \rho_3 > \rho_2$

(3) $\rho_1 < \rho_2 < \rho_3$

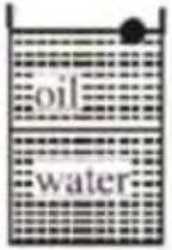
(4*) $\rho_1 < \rho_3 < \rho_2$



Ans. (4)

72

4. A ball is made of a material of density ρ where $\rho_{oil} < \rho < \rho_{water}$ with ρ_{oil} and ρ_{water} representing the densities of oil and water, respectively. The oil and water are immiscible. If the above ball is in equilibrium in a mixture of this oil and water, which of the following pictures represents its equilibrium position ? **[AIEEE-2010]**

(1) 

(2) 

(3*) 

(4) 

Ans. (3)

73

5. Water is flowing continuously from a tap having an internal diameter 8×10^{-3} m. The water velocity as it leaves the tap is 0.4 ms^{-1}. The diameter of the water stream at a distance 2×10^{-1} m below the tap is close to :- **[AIEEE-2011]**

(1) 9.6×10^{-3} m (2*) 3.6×10^{-3} m (3) 5.0×10^{-3} m (4) 7.5×10^{-3} m

Ans. (2)

6. Work done in increasing the size of a soap bubble from a radius of 3 cm to 5cm is nearly (Surface tension of soap solution = 0.03 Nm^{-1}) :- **[AIEEE-2011]**

(1) 2π mJ (2*) $0.4\,\pi$ mJ (3) 4π mJ (4) $0.2\,\pi$ mJ

Ans. (2)

7. Two mercury drops (each of radius 'r') merge to form a bigger drop. The surface energy of the bigger drop, ifs T is the surface tension, is : **[AIEEE-2011]**

(1) $2^{5/3}\pi r^2 T$ (2) $4\pi r^2 T$ (3) $2\pi r^2 T$ (4*) $2^{8/3}\pi r^2 T$

75

Ans. (4)

8. If a ball of steel (density $\rho = 7.8$ g cm^{-3}) attains a terminal velocity of 10 cm s^{-1} when falling in a tank of water (coefficient of viscosity $\eta_{water} = 8.5 \times 10^{-4}$ Pa.s) then its terminal velocity in glycerine ($\rho = 1.2$ g cm^{-3}, $\eta = 13.2$ Pa.s) would be nearly :- **[AIEEE-2011]**

76

(1) 1.6×10^{-5} cm s^{-1}

(2*) 6.25×10^{-4} cm s^{-1}

(3) 6.45×10^{-4} cm s^{-1}

(4) 1.5×10^{-5} cm s^{-1}

Ans. (2)

9. A thin liquid film formed between a U-shaped wire and a light slider supports a weight of 1.5×10^{-2} N (see figure). The length of the slider is 30 cm and its weight negligible. The surface tension of the liquid film is :- **[AIEEE-2012]**

78

(1) 0.025 Nm^{-1}

(2) 0.0125 Nm^{-1}

(3) 0.1 Nm^{-1}

(4) 0.05 Nm^{-1}

Ans. (1)

79

10. A uniform cylinder of length L and mass M having cross- sectional area A is suspended, with its length vertical, form a fixed point by a massless spring, such that it is half submerged in a liquid of density σ at equilibrium position. The extension x_0 of the spring when it is in equilibrium is :

[AIEEE-2013]

(1) $\frac{Mg}{k}$ (2) $\frac{Mg}{k}\left(1-\frac{LA\sigma}{M}\right)$ (3) $\frac{Mg}{k}\left(1-\frac{LA\sigma}{2M}\right)$ (4) $\frac{Mg}{k}\left(1+\frac{LA\sigma}{M}\right)$

(Here k is spring constant)

Ans. (3)

1. **STATEMENT-1 :** The stream of water flowing at high speed from a garden hose pipe tends to spread like a fountain when held vertically up, but tends to narrow down when held vertically down.
and
STATEMENT-2 : In any steady flow of an incompressible fluid, the volume flow rate of the fluid remains constant. **[IIT-JEE 2008]**

(A) STATEMENT-1 is True, STATEMENT-2 is True ; STATEMENT-2 is a correct explanation for STATEMENT-1

(B) STATEMENT-1 is True, STATEMENT-2 is True ; STATEMENT-2 is NOT a correct explanation for STATEMENT-1

(C) STATEMENT-1 is True, STATEMENT-2 is False

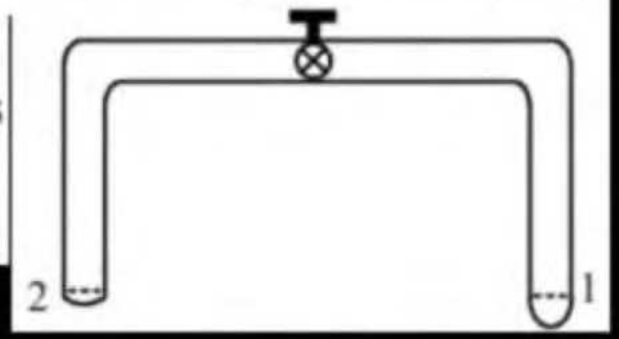
(D) STATEMENT-1 is False, STATEMENT-2 is True

Ans. (A)

2. A glass tube of uniform internal radius (r) has a valve separating the two identical ends. Initially, the valve is in a tightly closed position. End 1 has a hemispherical soap bubble of radius r. End 2 has sub-hemispherical soap bubble as shown in figure. Just after opening the valve, **[IIT-JEE 2008]**

81

(A) air from end 1 flows towards end 2. No change in the volume of the soap bubbles
(B) air from end 1 flows towards end 2. Volume of the soap bubble at end 1 decreases
(C) no change occurs
(D) air from end 2 flows towards end 1. Volume of the soap bubble at end 1 increases



Ans. (B)

82

If two soap bubbles of different radii are connected by a tube- [AIEEE - 2004]

(A) air flows from the bigger bubble to the smaller bubble till the sizes become equal

(B) air flows from bigger bubble to the smaller bubble till the sizes are interchanged

(C*) air flows from the smaller bubble to the bigger bubble

(D) there is no flow of air

Ans. (C)

B3

Two soap bubbles A and B are kept in a closed chamber where the air is maintained at pressure 8N/m^2. The radii of bubbles A and B are 2 cm and 4cm, respectively. Surface tension of the soap-water used to make bubbles is 0.04 N/m. Find the ratio n_B/n_A, where n_A and n_B are the number of moles of air in bubbles A and B, respectively. [Neglect the effect of gravity] **[IIT-JEE-2009]**

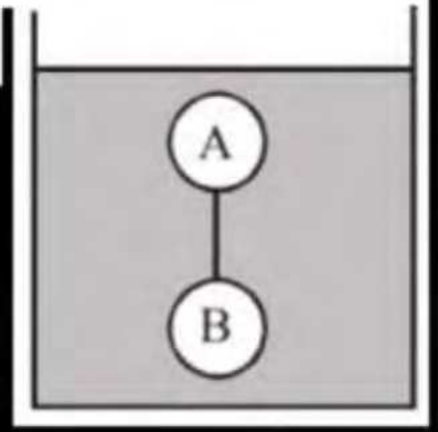
Ans. (6)

B4

Two solid spheres A and B of equal volumes but of different densities d_A and d_B are connected by a string. They are fully immersed in a fluid of density d_F. They get arranged into an equilibrium state as shown in the figure with a tension in the string. The arrangement is possible only if

[IIT-JEE-2011]

(A) $d_A < d_F$ (B) $d_B > d_F$ (C) $d_A > d_F$ (D) $d_A + d_B = 2d_F$



Ans (A,B,D)

85 A solid sphere of radius R and density ρ is attached to one end of a mass-less spring of force constant k. The other end of the spring is connected to another solid sphere of radius R and density 3ρ. The complete arrangement is placed in a liquid of density 2ρ and is allowed to reach equilibrium. The correct statement(s) is (are)

[IIT-JEE-2013]

(A) the net elongation of the spring is $\frac{4\pi R^3 \rho g}{3k}$

(B) the net elongation of the spring is $\frac{8\pi R^3 \rho g}{3k}$

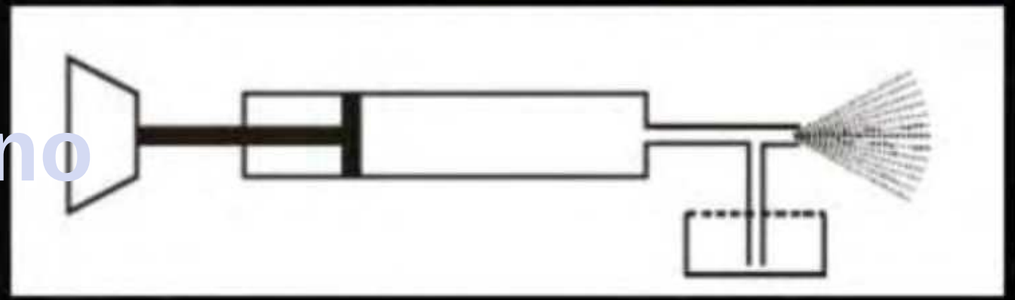
(C) the light sphere is partially submerged.

(D) the light sphere is completely submerged.

Ans. (A, D)

A spray gun is shown in the figure where a piston pushes air out of a nozzle. A thin tube of uniform cross section is connected to the nozzle. The other end of the tube is in a small liquid container. As the piston pushes air through the nozzle, the liquid from the container rises into the nozzle and is sprayed out. For the spray gun shown, the radii of the piston and the nozzle are 20 mm and 1 mm respectively. The upper end of the container is open to the atmosphere.

[JEE Advanced-2014]



86

If the piston is pushed at a speed of 5 mms^{-1}, the air comes out of the nozzle with a speed of

(A) 0.1 ms^{-1} (B) 1 ms^{-1} (C) 2 ms^{-1} (D) 8 ms^{-1}

Ans. (C)

87

If the density of air is ρ_a and that of the liquid ρ_ℓ, then for a given piston speed the rate (volume per unit time) at which the liquid is sprayed will be proportional to

(A) $\sqrt{\frac{\rho_a}{\rho_\ell}}$ (B) $\sqrt{\rho_a \rho_\ell}$ (C) $\sqrt{\frac{\rho_\ell}{\rho_a}}$ (D) $\rho\ell$

Ans. (A)

88

A person in a lift is holding a water jar, which has a small hole at the lower end of its side. When the lift is at rest, the water jet coming out of the hole hits the floor of the lift at a distance d of 1.2 m from the person. In the following, state of the lift's motion is given in List I and the distance where the water jet hits the floor of the lift is given in List II. Match the statements from List I with those in List II and select the correct answer using the code given below the lists.

List - I **List-II** **[JEE Advanced-2014]**

(P) Lift is accelerating vertically up.

(Q) Lift is accelerating vertically down with an acceleration less than the gravitational acceleration.

(R) Lift is moving vertically up with constant speed.

(S) Lift is falling freely.

(1) $d = 1.2$ m

(2) $d > 1.2$ m

(3) $d < 1.2$ m

(4) No water leaks out of the jar

Code :

(A) P-2, Q-3, R-2, S-4

(B) P-2, Q-3, R-1, S-4

(C) P-1, Q-1, R-1, S-4

(D) P-2, Q-3, R-1, S-1

Ans. (C)

89

Consider two solid spheres P and Q each of density 8 gm cm^{-3} and diameters 1 cm and 0.5 cm, respectively. Sphere P is dropped into a liquid of density 0.8 gm cm^{-3} and viscosity η = 3 poiseulles. Sphere Q is dropped into a liquid of density 1.6 gm cm^{-3} and viscosity $\eta = 2$ poiseulles. The ratio of the terminal velocities of P and Q is. **[JEE Advanced-2016]**

Ans. (3)

90

A drop of liquid of radius $R = 10^{-2}$ m having surface tension $S = \frac{0.1}{4\pi} Nm^{-1}$ divides itself into n K identical drops. In this process the total change in the surface energy $\Delta U = 10^{-3}$ J. If $K = 10^{\alpha}$ then the value of α is

[JEE Advanced-2017]

Ans. (6)

9

A uniform capillary tube of inner radius r is dipped vertically into a beaker filled with water. The water rises to a height h in the capillary tube above the water surface in the beaker. The surface tension of water is σ. The angle of contact between water and the wall of the capillary tube is θ. Ignore the mass of water in the meniscus. Which of the following statements is (are) true? **[JEE Advanced-2018]**

$h = \frac{2S\cos\theta}{r\rho g} = 2\sigma\cos\theta/r\rho g$

(A) For a given material of the capillary tube, h decreases with increase in r

(B) For a given material of the capillary tube, h is independent of σ.

(C) If this experiment is performed in a lift going up with a constant acceleration, then h decreases.,

(D) h is proportional to contact angle θ.

$g_{eff} = g + a$

① $\gamma \uparrow \quad h \downarrow$

② $h \propto s'$

$h = \frac{2S\cos\theta}{r\rho g}$

$h \propto \theta$ X

$h \propto \cos\theta$

Ans (A,C)

92

Consider a thin square plate floating on a viscous liquid in a large tank. The height h of the liquid in the tank is much less than the width of the tank. The floating plate is pulled horizontally with a constant velocity u_0. Which of the following statements is (are) true ?**[JEE Advanced-2018]**

(A) The resistive force of liquid on the plate is inversely proportional to h

(B) The resistive force of liquid on the plate is independent of the area of the plate

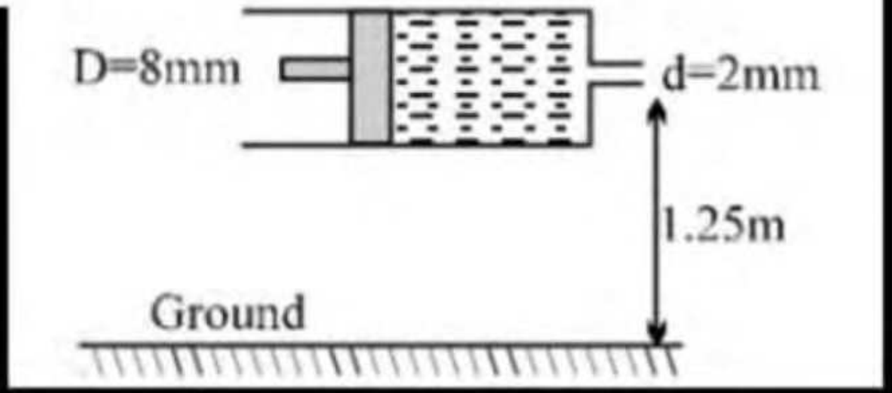
(C) The tangential (shear) stress on the floor of the tank increases with u_0.

(D) The tangential (shear) stress on the plate varies linearly with the viscosity η of the liquid.

Ans (A,C,D)

7. Consider a horizontally oriented syringe containing water located at a height of 1.25 m above the ground. The diameter of the plunger is 8 mm and the diameter of the nozzle is 2 mm. The plunger is pushed with a constant speed of 0.25 m/s. Find the horizontal range of water stream on the ground. Take $g = 10\ m/s^2$.

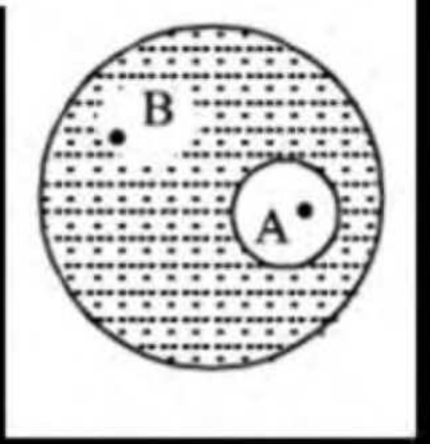
[IIT-JEE 2004]



Ans. x = 2 m

12. There is an air bubble of radius R inside a drop of water of radius 3R. Find the ratio of gauge pressure at point A to the gauge pressure at point B.

94



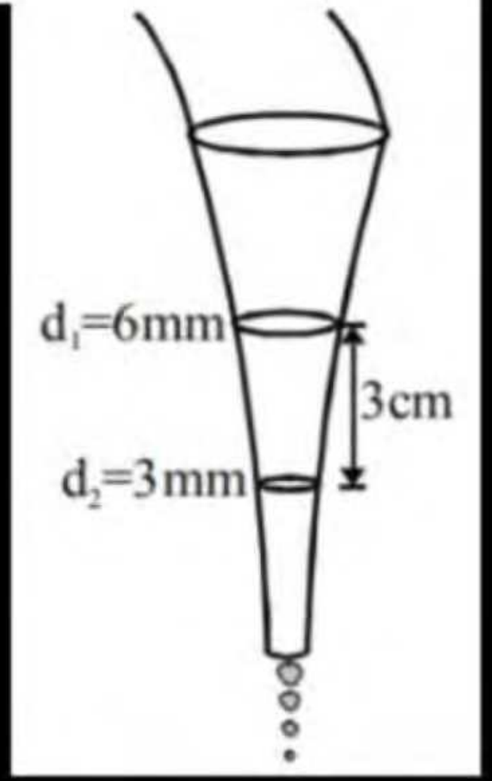
Ans. 4

13. Two arms of a U-tube have unequal diameters $d_1 = 1.0$ mm and $d_2 = 1.0$ cm. If water (surface tension 7×10^{-2} N/m) is poured into the tube held in the vertical position, find the difference of level of water in the U-tube. Assume the angle of contact to be zero.

Ans. 2.52 cm

96

21. The tap in the garden was closed in appropriately resulting in the water flowing freely out of it which forms a downward narrowing beam. The beam of water has a circular cross-section, the diameter of the circle is 6 mm at one point and 3 cm below it is only 3 mm as shown in figure. If the rate of water wasted is $(x \times \pi)$ mL/minute then find the value of x. (Neglect the effect of viscosity and surface tension of the flowing water.)



Ans. 108

A tube is attached as shown in closed vessel containing water. The velocity of water coming out from a small hole is :

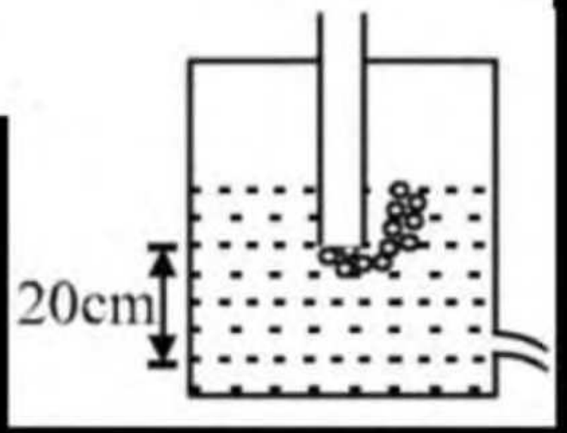
97

(A) $\sqrt{2}$ m/s

(B*) 2 m/s

(C) depends on pressure of air inside vessel

(D) None of these



Ans. (B)

98

A large tank is filled with water to a height H. A small hole is made at the base of the tank. It takes T_1 time to decrease the height of water to H/η, $(\eta > 1)$ and it takes T_2 time to take out the rest of water. If $T_1 = T_2$, then the value of η is :

(A) 2 (B) 3 (C) 4 (D) $2\sqrt{2}$

Ans. (C)

99

Spherical balls of radius R are falling in a viscous fluid of viscosity η with a velocity v. the retarding viscous force acting on the spherical ball is- **[AIEEE - 2004]**

(A) directly proportional to R but inversely proportional to v

(B*) directly proportional to both radius R and velocity v

(C) inversely proportional to both radius R and velocity v

(D) inversely proportional to R but directly proportional to velocity v

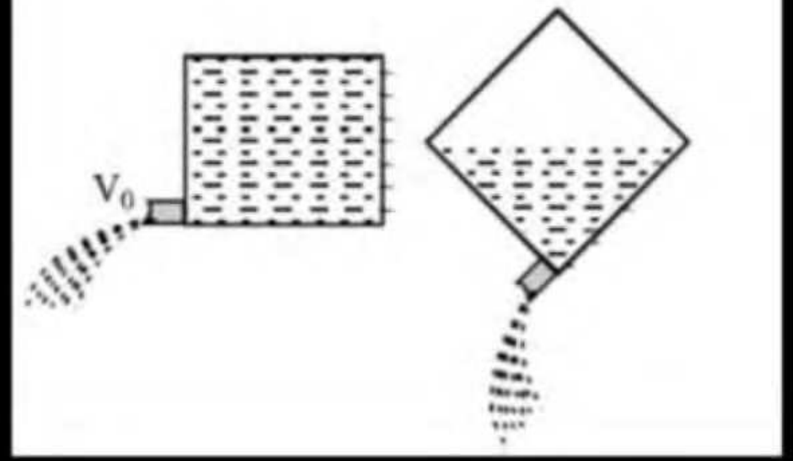
Ans. (B)

100

A cubical box of wine has a small spout located in one of the bottom corners. When the box is full and placed on a level surface, opening the spout results in a flow of wine with a initial speed of v_0 (see figure). When the box is half empty, someone tilts it at 45° so that the spout is at the lowest point (see figure). When the spout is opened the wine will flow out with a speed of

(A) v_0 (B) $v_0/2$

(C) $v_0/\sqrt{2}$ (D) $v_0/\sqrt[4]{2}$



Ans. (D)

101

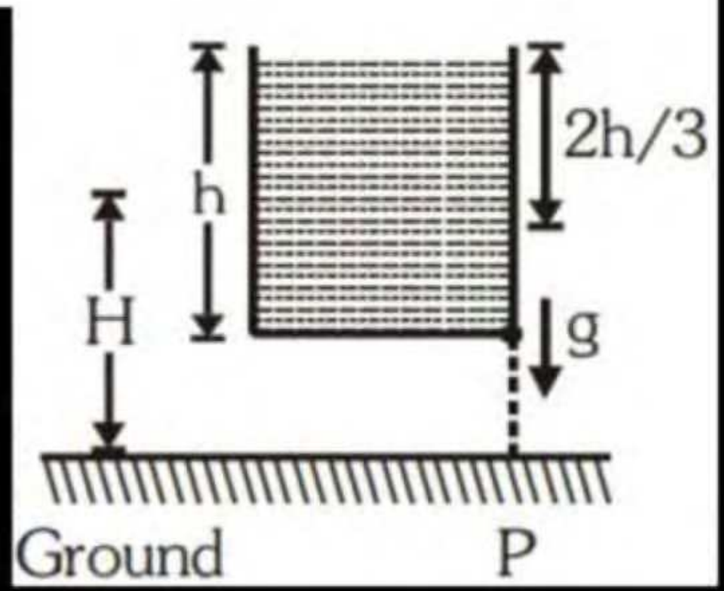
An open vessel full of water is falling freely under gravity. There is a small hole in one face of the vessel, as shown in the figure. The water which comes out from the hole at the instant when hole is at height H above the ground, strikes the ground at a distance of x from P. Which of the following is correct for the situation described ?

(A) The value of x is $2\sqrt{\frac{2hH}{3}}$

(B) The value of x is $\sqrt{\frac{4hH}{3}}$

(C) The value of x can't be computed from information provided.

(D) The question is irrevalent as no water comes out from the hole.



Ans. (D)

Question

102

A air bubble of radius 1 cm in water has an upward acceleration 9.8 cm s^{-2}. The density of water is 1 gm cm^{-3} and water offers negligible drag force on the bubble. The mass of the bubble is ($g = 980\ cm/s^2$)

(JEE Mains 2020)

(A) 3.15 gm

(B) 4.51 gm

(C) 4.15 gm

(D) 1.52 g

Ans. (C)

Question

A soap bubble of radius 3 cm is formed inside the another soap bubble of radius 6 cm. The radius of an equivalent soap bubble which has the same excess pressure as inside the smaller bubble with respect to the atmospheric pressure is ..... cm .

(JEE Mains 2021)

103

Ans. (2)

Question 104

Given below are two statements: one is labelled as Assertion A and the other is labelled as Reason R

Assertion A: When you squeeze one end of a tube to get toothpaste out from the other end, Pascal's principle is observed.

Reason R: A change in the pressure applied to an enclosed incompressible fluid is transmitted undiminished to every portion of the fluid and to the walls of its container.

In the light of the above statements, choose the most appropriate answer from the options given below.

(06 April 2023 - Shift 2)

(A) Both A and R are correct but R is NOT the correct explanation of A

(B) A is not correct but R is correct

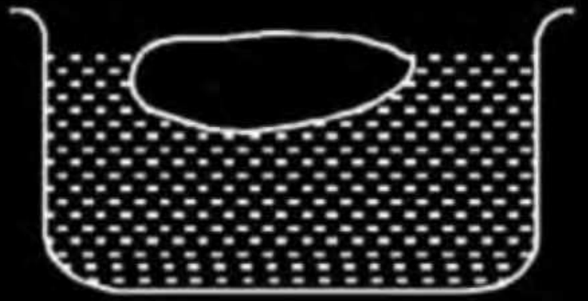
(C) A is correct but R is not correct

(D) Both A and R is correct and R is the correct explanation of A

Ans. (D)

Question 105

A body floats in a liquid contained in a beaker. The whole system as shown in Figure falls freely under gravity. The up thrust on the body is/are:



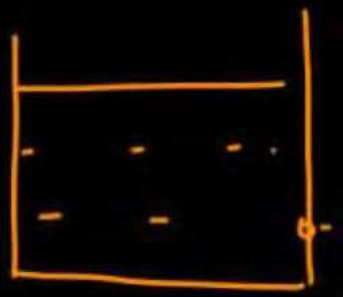
1. Zero
2. equal to the weight of the liquid displaced
3. equal to the weight of the body in air
4. equal to the weight of the immersed portion of the body

Ans. (1)

Question 106

The top of a water tank is open to air and its water level is maintained. It is giving out $0.74 m^2$ water per minute through a circular opening of 2 cm radius in its wall. The depth of the centre of the opening from the level of water in the tank is close to:

(JEE Mains 2019)



1. 6.0 m
2. 4.8 m
3. 9.6 m
4. 2.9 m

$$\frac{dVol^n}{dt} = A_h v$$

$$\frac{.74}{60} = A_h \cdot \sqrt{2gh} = \pi r^2 \sqrt{2gh}$$

$$\left(\frac{.74}{60}\right)^2 = (\pi r^2)^2 \times 2gh$$

$$h = \left(\frac{.74}{60}\right)^2 \times \frac{1}{\pi^2 r^4 2g} \approx 4.8\,m \text{ (Approx)}$$

Ans. (2)

Question 107

The ratio of surface tensions of mercury and water is given to be 7.5 while the ratio of their densities is 13.6. Their contact angles, with glass, are close to 135° and 0°, respectively. It is observed that mercury gets depressed by an amount h in a capillary tube of radius r_1, while water rises by the same amount h in a capillary tube of radius r. The ratio, (1/1), is then close to: **(JEE Mains 2019)**

1. 4/5
2. 2/5
3. 3/5
4. 2/3

Ans. (2)