Fluid Mechanics (XE - B)

Question Number : 12 **Correct : 1 Wrong : -0.33**

In a given flow field, the velocity vector in Cartesian coordinate system is given as:

$$\vec{V} = \left(x^2 + y^2 + z^2\right)\hat{i} + \left(xy + yz + y^2\right)\hat{j} + \left(xz - z^2\right)\hat{k}$$

What is the volume dilation rate of the fluid at a point where $x = 1$, $y = 2$ and $z = 3$?

(A) 6 (B) 5 (C) 10 (D) 0

Question Number : 13 **Correct : 1 Wrong : -0.33**

A steady, incompressible, two-dimensional velocity field in Cartesian coordinate system is represented by the following expression.

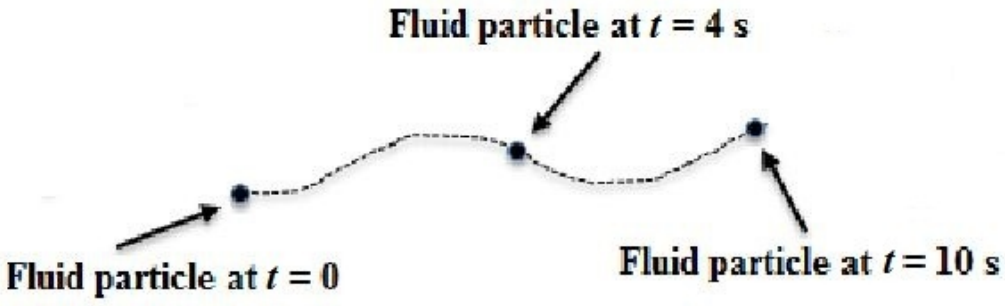
$$\vec{V} = (0.7 + 0.4x)\hat{i} + (1.2 - 0.4y)\hat{j}$$

The coordinates of the point (x, y) in the flow field having "zero" velocity is,

(A) (1.75, –3) (B) (–1.75, 3) (C) (1.75, 3) (D) (–1.75, –3)

Question Number : 14 **Correct : 1 Wrong : -0.33**

During an experiment, the position of a fluid particle is monitored by an instrument over a time period of 10 s. The trace of the particle given by the following figure represents a



(A) streamline (B) streakline (C) pathline (D) timeline

Question Number : 15 **Correct : 1 Wrong : -0.33**

In a Cartesian two-dimensional coordinate system, u and v represent the velocities in x and y directions, respectively. For a certain flow, the velocity field is represented by the following expression:

$$\dot{V} = (ax + by)\,\hat{i} + (cx + dy)\,\hat{j}$$

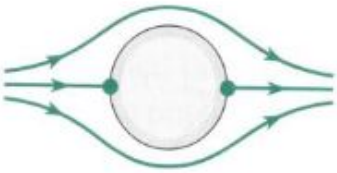
where, the coefficients a, b, c and d are constants. For an incompressible flow, which one of the following relations is TRUE?

(A) $a + d = 0$ (B) $a + c = 0$ (C) $b + d = 0$ (D) $b + c = 0$

Question Number : 16 **Correct : 1 Wrong : -0.33**

Which one of the following figures represents potential flow past a circular cylinder with clock-wise rotation of the cylinder?

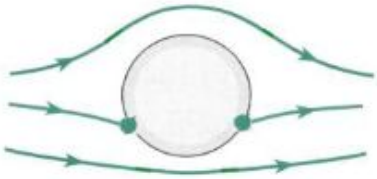
(A)



(B)

(C)

(D)



Question Number : 17 **Correct : 1 Wrong : -0.33**

The stream function (Ψ) of a velocity field at any location (x, y) is given as, $\Psi = xy^2 - 2x^2y^2$. What is the rate of rotation of a fluid element located at ($x = 2$, $y = 2$)?

(A) 8 (B) 10 (C) 12 (D) 14

Question Number : 18 **Correct : 1 Wrong : -0.33**

The nature of velocity profile within the laminar viscous sublayer in a turbulent pipe flow is

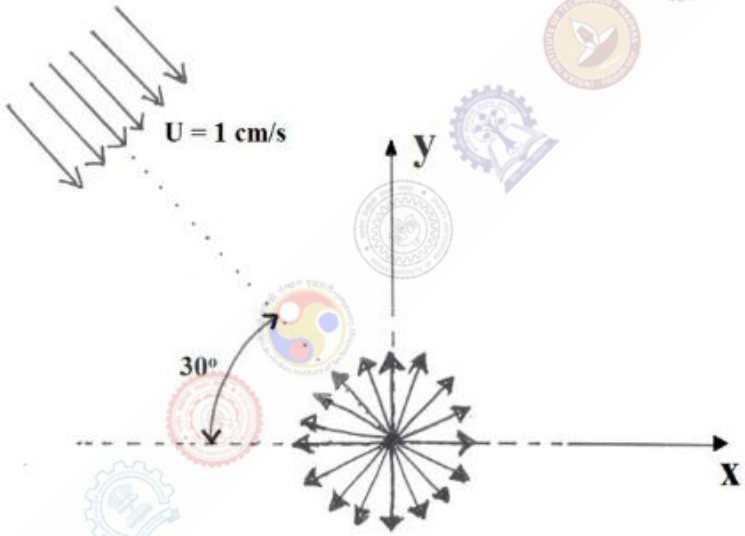
(A) linear (B) parabolic (C) logarithmic (D) exponential

Question Number : 19 Correct : 1 Wrong : 0

In a 5 m deep vertical cylindrical tank, water is filled up to a level of 3 m from the bottom and the remaining space is filled with oil of specific gravity 0.88. Assume density of water as 1000 kg/m^3 and acceleration due to gravity to be 10 m/s^2. The gauge pressure (in kN/m^2, rounded off to the first decimal place) at a depth of 2.5 m from the top of the tank will be _____

Question Number : 20 Correct : 1 Wrong : -0.33

In a two-dimensional potential flow, a point source is located at the origin ($x = 0, y = 0$) as shown in the figure. The strength of the point source is 2 cm^2/s. A uniform flow with velocity 1 cm/s is approaching towards the point source at an angle of 30° from the horizontal axis. What is the distance (cm) of the stagnation point in the flow field from the point source?



(A) $\frac{1}{\pi}$

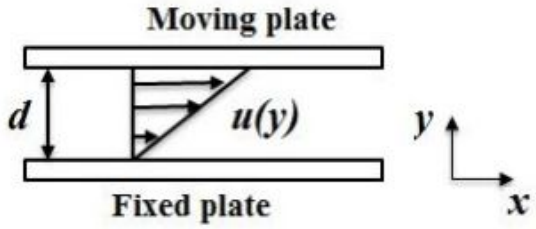
(B) $\frac{2}{\pi}$

(C) $\frac{1}{2\pi}$

(D) $\frac{\sqrt{3}}{2\pi}$

Question Number : 21 Correct : 2 Wrong : 0

Two infinite parallel horizontal plates are separated by a small gap $(d = 20\ \text{mm})$ as shown in figure. The bottom plate is fixed and the gap between the plates is filled with oil having density of 890 kg/m^3 and kinematic viscosity of 0.00033 m^2/s. A shear flow is induced by moving the upper plate with a velocity of 5 m/s. Assume, linear velocity profile between the plates and the oil to be a Newtonian fluid. The shear stress (N/m^2) at the upper plate is _____



Question Number : 22 Correct : 2 Wrong : 0

A spherical balloon of diameter 15 m is supposed to lift a load of 3000 N. The lifting of load is achieved by heating the air inside the balloon. Assume, air to be an ideal gas and atmospheric pressure either outside or inside the balloon. The value of acceleration due to gravity is 9.81 m/s^2 and the values of temperature and density of atmospheric air are 15°C and 1.2 kg/m^3, respectively. In order to lift the specified load, the air inside the balloon should be heated to a temperature (°C) of _____

Question Number : 23 Correct : 2 Wrong : -0.66

The velocity field in Cartesian coordinate system for a two-dimensional steady flow is given as:

$$\vec{V} = \left(\frac{V_0}{L}\right)\left(x\,\hat{i} - y\,\hat{j}\right)$$

where, V_0 and L are constants. Which one of the following expressions represents the acceleration field $(\vec{a})$ for this flow?

(A) $\vec{a} = 0$

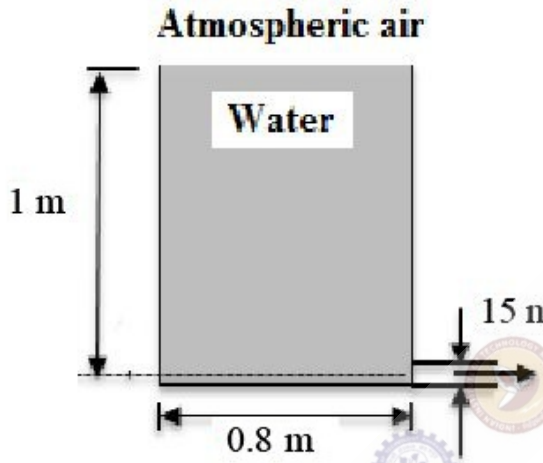
(B) $\vec{a} = \left(\frac{V_0}{L}\right)\left(x\,\hat{i} + y\,\hat{j}\right)$

(C) $\vec{a} = \left(\frac{V_0^2}{L^2}\right)\left(x\,\hat{i} - y\,\hat{j}\right)$

(D) $\vec{a} = \left(\frac{V_0^2}{L^2}\right)\left(x\,\hat{i} + y\,\hat{j}\right)$

Question Number : 24 Correct : 2 Wrong : -0.66

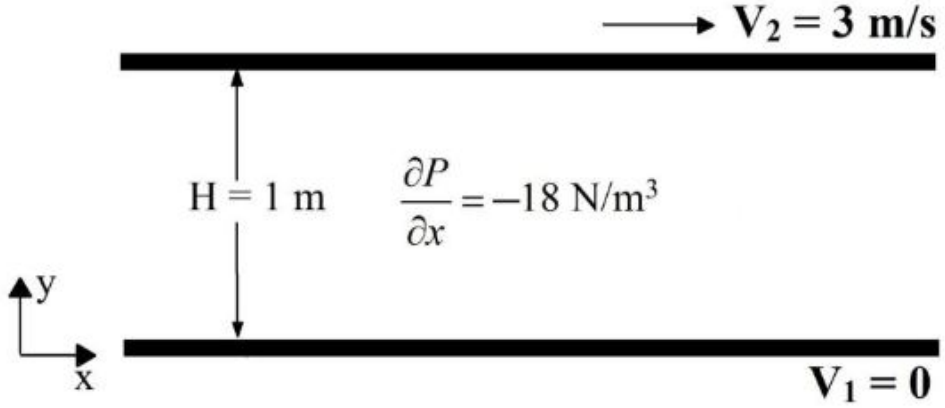
A cylindrical tank of 0.8 m diameter is completely filled with water and its top surface is open to atmosphere as shown in the figure. Water is being discharged to the atmosphere from a circular hole of 15 mm diameter located at the bottom of the tank. The value of acceleration due to gravity is 9.81 m/s^2. How much time (in seconds) would be required for water level to drop from a height of 1 m to 0.5 m?



(A) 188 (B) 266 (C) 376 (D) 642

Question Number : 25 Correct : 2 Wrong : 0

Consider steady laminar flow of an incompressible Newtonian fluid between two infinite parallel plates, separated by a distance of 1 m, as shown in the figure. The bottom plate is stationary but the top one is moving in positive x- direction with a velocity of 3 m/s. The fluid pressure gradient in the flow direction is: $\frac{\partial P}{\partial x} = -18\ N/m^3$. If the viscosity of the fluid is 1 kg m^{-1} s^{-1} then the distance of the point of maximum velocity (in meters, rounded off to the second decimal place) from the bottom plate would be _____

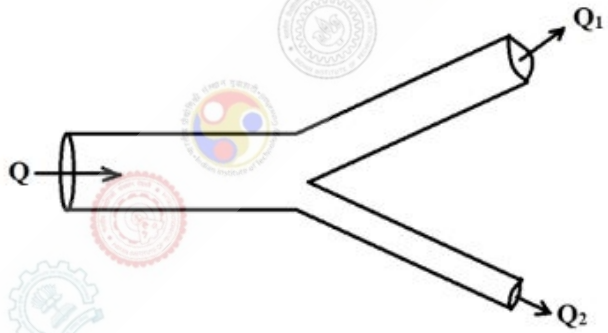


Question Number : 26 Correct : 2 Wrong : 0

An inviscid incompressible fluid of density 1000 kg/m^3 is flowing in a horizontal pipe of tapered cross-section with a flow rate of 4000 cm^3/s. The area of cross-section at two different locations 'A' and 'B' are 10 cm^2 and 20 cm^2, respectively. The velocity of the fluid at the location 'A' is 4 m/s and pressure is 5 N/m^2. The pressure (N/m^2) at location 'B' would be _____

Question Number : 27 Correct : 2 Wrong : 0

A viscous, incompressible and Newtonian fluid flowing through the main branch of a circular pipe bifurcates into two daughter branches whose radii are 4 cm and 2 cm, respectively. The flow in both the daughter branches are laminar and fully developed. If the pressure gradients in both the daughter branches are same, then fraction of total volumetric flow rate (rounded off to the second decimal place) coming out from the branch with 4 cm diameter is _____



Question Number : 28 Correct : 2 Wrong : -0.66

The volumetric flow rate (Q) of a triangular notch is a function of the upstream liquid surface elevation (H) measured from the bottom of the notch, acceleration due to gravity (g), notch angle (ϕ) and the approach velocity (V). Which one of the following is the correct expression for Q ?

(A) $Q = H^{1/2} f\left(\frac{V}{\sqrt{H}}, \phi\sqrt{g}\right)$

(B) $Q = H f\left(\frac{V}{\sqrt{H}}, \phi\sqrt{g}\right)$

(C) $Q = H^{3/2} f\left(\frac{V}{\sqrt{H}}, \phi\sqrt{g}\right)$

(D) $Q = H^{5/2} f\left(\frac{V}{\sqrt{H}}, \phi\sqrt{g}\right)$

Question Number : 29 **Correct : 2 Wrong : 0**

Model tests are to be carried out to study the flow through a large prototype valve of 0.6 m diameter at a flow rate of 10 m^3/s. The same working fluid is used for both the model and the prototype. A complete geometric similarity is maintained between the model and the prototype. If the valve diameter of the model is 80 mm, its required flow rate (in m^3/s, rounded off to the first decimal place) would be _____

Question Number : 30 **Correct : 2 Wrong : 0**

Water is flowing at a rate of 0.5 m^3/s in a horizontal pipeline of inside diameter 0.5 m. The density and kinematic viscosity of water is 1000 kg/m^3 and 10^{-6} m^2/s, respectively. Assume Darcy-Weisbach friction factor value to be 0.0093 and acceleration due to gravity as 9.81 m/s^2. To maintain constant flow rate, the required power per unit length of the pipeline (in W/m, rounded off to the first decimal place) would be _____

Question Number : 31 **Correct : 2 Wrong : 0**

Air flows over a smooth flat plate at a velocity of 4.39 m/s. The density of air is 1.031 kg/m^3 and the kinematic viscosity is 1.34×10^{-5} m^2/s. The plate length is 12.2 m in the direction of the flow. The boundary layer thickness (δ) is given as $\frac{0.37X}{(\mathrm{Re}_X)^{1/5}}$, where X is the distance from the leading edge and Re_X is the Reynolds number. The boundary layer thickness (in meters, rounded off to the second decimal place) at 12.2 m from the leading edge will be _____

Question Number : 32 **Correct : 2 Wrong : 0**

A venturimeter of diameter 0.2 m at the entrance and 0.1 m at the throat is inclined upwards. The vertical elevation difference between the entrance and the throat is 0.5 m. The density of water is 1000 kg/m^3 and the coefficient of velocity is 0.97. The differential U-tube manometer connected to the entrance and throat shows a pressure difference of 30 kN/m^2. Assume acceleration due to gravity as 9.81 m/s^2. The velocity of the water (in m/s, rounded off to the first decimal place) at the throat would be _____

Question Number : 33 **Correct : 2 Wrong : -0.66**

A spherical bubble of radius r is rising upward with a constant velocity U, in quiescent water of dynamic viscosity μ. The density of air and water are denoted by ρ_a and ρ_w, respectively, and g is acceleration due to gravity. The bubble motion is such that, the Reynolds number, Re << 1. The density of air can be neglected in comparison to the water density ($\rho_a \ll \rho_w$). Which one of the following expressions is TRUE for the density of water?

(A) $\rho_w = \frac{2}{9}\frac{\mu U}{r^2 g}$

(B) $\rho_w = \frac{9}{2}\frac{\mu U}{r^2 g}$

(C) $\rho_w = \frac{9}{4}\frac{\mu U}{r^2 g}$

(D) $\rho_w = \frac{4}{9}\frac{\mu U}{r^2 g}$

General Aptitude

Question Number : 166 **Correct : 1 Wrong : -0.33**

The event would have been successful if you _____able to come.

(A) are (B) had been (C) have been (D) would have been

Question Number : 167 **Correct : 1 Wrong : -0.33**

There was no doubt that their work was thorough.

Which of the words below is closest in meaning to the underlined word above?

(A) pretty (B) complete (C) sloppy (D) haphazard

Question Number : 168 Correct : 1 Wrong : -0.33

Four cards lie on a table. Each card has a number printed on one side and a colour on the other. The faces visible on the cards are 2, 3, red, and blue.

Proposition: If a card has an even value on one side, then its opposite face is red.

The cards which MUST be turned over to verify the above proposition are

(A) 2, red (B) 2, 3, red (C) 2, blue (D) 2, red, blue

Question Number : 169 Correct : 1 Wrong : -0.33

What is the value of x when $81 \times \left(\frac{16}{25}\right)^{x+2} \div \left(\frac{3}{5}\right)^{2x+4} = 144$?

(A) 1 (B) -1 (C) -2 (D) Cannot be determined

Question Number : 170 Correct : 1 Wrong : -0.33

Two dice are thrown simultaneously. The probability that the product of the numbers appearing on the top faces of the dice is a perfect square is

(A) 1/9 (B) 2/9 (C) 1/3 (D) 4/9

Question Number : 171 Correct : 2 Wrong : -0.66

Bhaichung was observing the pattern of people entering and leaving a car service centre. There was a single window where customers were being served. He saw that people inevitably came out of the centre in the order that they went in. However, the time they spent inside seemed to vary a lot: some people came out in a matter of minutes while for others it took much longer.

From this, what can one conclude?

(A) The centre operates on a first-come-first-served basis, but with variable service times, depending on specific customer needs.
(B) Customers were served in an arbitrary order, since they took varying amounts of time for service completion in the centre.
(C) Since some people came out within a few minutes of entering the centre, the system is likely to operate on a last-come-first-served basis.
(D) Entering the centre early ensured that one would have shorter service times and most people attempted to do this.

Question Number : 172 **Correct : 2 Wrong : -0.66**

A map shows the elevations of Darjeeling, Gangtok, Kalimpong, Pelling, and Siliguri. Kalimpong is at a lower elevation than Gangtok. Pelling is at a lower elevation than Gangtok. Pelling is at a higher elevation than Siliguri. Darjeeling is at a higher elevation than Gangtok.

Which of the following statements can be inferred from the paragraph above?

i. Pelling is at a higher elevation than Kalimpong
ii. Kalimpong is at a lower elevation than Darjeeling
iii. Kalimpong is at a higher elevation than Siliguri
iv. Siliguri is at a lower elevation than Gangtok

(A) Only ii (B) Only ii and iii (C) Only ii and iv (D) Only iii and iv

Question Number : 173 **Correct : 2 Wrong : -0.66**

P, Q, R, S, T and U are seated around a circular table. R is seated two places to the right of Q. P is seated three places to the left of R. S is seated opposite U. If P and U now switch seats, which of the following must necessarily be true?

(A) P is immediately to the right of R
(B) T is immediately to the left of P
(C) T is immediately to the left of P or P is immediately to the right of Q
(D) U is immediately to the right of R or P is immediately to the left of T

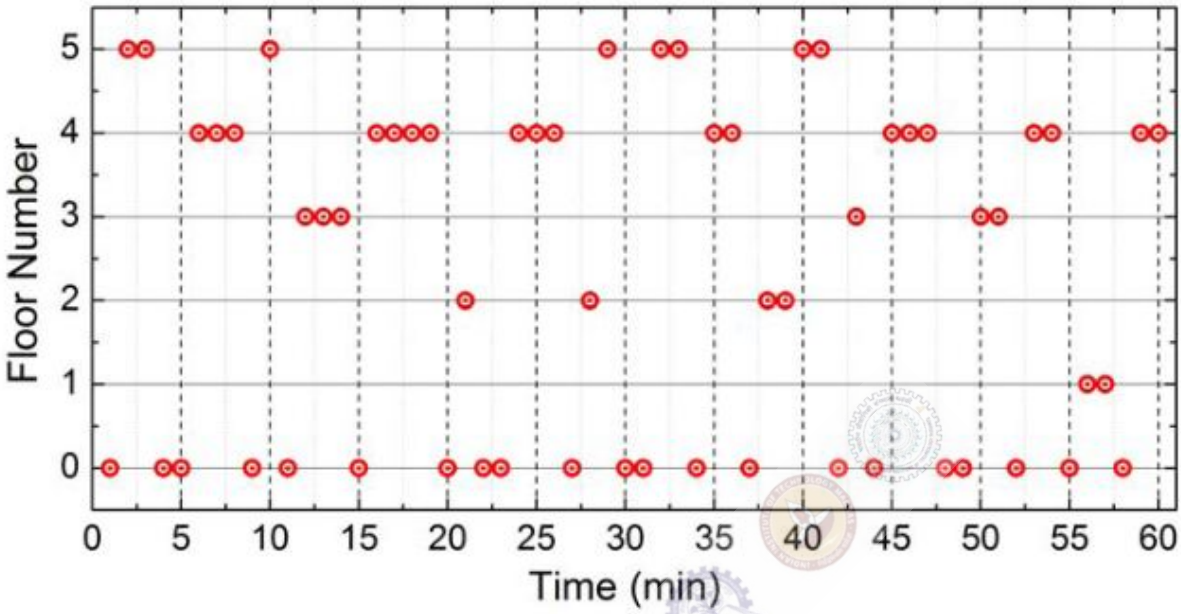
Question Number : 174 **Correct : 2 Wrong : -0.66**

Budhan covers a distance of 19 km in 2 hours by cycling one fourth of the time and walking the rest. The next day he cycles (at the same speed as before) for half the time and walks the rest (at the same speed as before) and covers 26 km in 2 hours. The speed in km/h at which Budhan walks is

(A) 1 (B) 4 (C) 5 (D) 6

Question Number : 175 **Correct : 2 Wrong : -0.66**

The points in the graph below represent the halts of a lift for durations of 1 minute, over a period of 1 hour.



Which of the following statements are correct?

i. The elevator never moves directly from any non-ground floor to another non-ground floor over the one hour period

ii. The elevator stays on the fourth floor for the longest duration over the one hour period

(A)) Only i (B) Only ii (C) Both i and ii (D) Neither i nor ii