National Testing Agency

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Advanced Concepts in Fluid Mechanics

Group Number :	1
Group Id :	489994202
Group Maximum Duration :	0
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Break time:	0
Group Marks:	100

Advanced Concepts in Fluid Mechanics

Section Id :	489994258
Section Number :	1
Section type :	Online
Mandatory or Optional:	Mandatory
Number of Questions:	50
Number of Questions to be attempted:	50
Section Marks:	100
Display Number Panel:	Yes
Group All Questions:	No

Sub-Section Number:	1
Sub-Section Id:	489994282
Question Shuffling Allowed :	Yes

Question Number : 1 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

Consider a steady, fully developed laminar flow of a constant property Newtonian fluid through a circular pipe of diameter D. The velocity profile in the pipe is given by $\frac{v_z}{v_{z,\max}} = \left(1 - \frac{4r^2}{D^2}\right)$, where r is the radial distance from the centreline of the pipe and $v_{z,\max}$ is the maximum velocity which occurs at the pipe centreline. The relationship between the maximum velocity, $v_{z,\max}$ and the average velocity, $\bar{v}_z$ is given by

A. $v_{z,\max} = \bar{v}_z$

B. $v_{z,\max} = 1.5\bar{v}_z$

C. $v_{z,\max} = 2\bar{v}_z$

D. $v_{z,\max} = 2.5\bar{v}_z$

Options :

1. 1
2. 2
3. 3
4. 4

Question Number : 2 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

Consider a steady, fully developed laminar flow of a constant property Newtonian fluid through a circular pipe of diameter D. The velocity profile in the pipe is given by $\frac{v_z}{v_{z,\max}} = \left(1 - \frac{4r^2}{D^2}\right)$, where r is the radial distance from the centreline of the pipe and $v_{z,\max}$ is the maximum velocity which occurs at the pipe centreline. Let $\bar{v}_z$ denote the average velocity of the flow. The shear stress at any location can be written as $\tau_{rz} = \mu\left(\frac{\partial v_r}{\partial z} + \frac{\partial v_z}{\partial r}\right)$. If the viscosity of the fluid is μ, the magnitude of wall shear stress is given by

A. $\frac{8\mu\bar{v}_z}{D}$

B. $\frac{4\mu\bar{v}_z}{D}$

C. $\frac{2\mu\bar{v}_z}{D}$

D. $\frac{\mu\bar{v}_z}{D}$

Options :

1. 1
2. 2
3. 3
4. 4

Question Number : 3 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

Consider a steady, fully developed laminar flow of a constant property Newtonian fluid through a circular pipe of diameter D. The velocity profile in the pipe is given by $\frac{v_z}{v_{z,\max}} = \left(1 - \frac{4r^2}{D^2}\right)$, where r is the radial distance from the centreline of the pipe and $v_{z,\max}$ is the maximum velocity which occurs at the pipe centreline. Let $\bar{v}_z$ denote the average velocity of the flow. If the viscosity of the fluid is μ, the pressure drop across a length L of the pipe is given by

A. $\frac{64\mu\bar{v}_z L}{D^2}$

B. $\frac{32\mu\bar{v}_z L}{D^2}$

C. $\frac{16\mu\bar{v}_z L}{D^2}$

D. $\frac{8\mu\bar{v}_z L}{D^2}$

Options :

1. 1
2. 2
3. 3
4. 4

Question Number : 4 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

Consider a steady, fully developed laminar flow of a constant property Newtonian fluid through a circular pipe of diameter D. The velocity profile in the pipe is given by $\frac{v_z}{v_{z,\max}} = \left(1 - \frac{4r^2}{D^2}\right)$, where r is the radial distance from the centreline of the pipe and $v_{z,\max}$ is the maximum velocity which occurs at the pipe centreline. The skin friction coefficient, C_f is defined as $C_f = \frac{|\tau_w|}{\frac{1}{2}\rho\bar{v}_z^2}$, where $\bar{v}_z$ denotes the average velocity of the flow and τ_w denotes the magnitude of wall shear stress. The relationship between the skin friction coefficient and the Reynolds number for pipe flow is given as

A. $C_f = \frac{8}{\mathrm{Re}_D}$

B. $C_f = \frac{16}{\mathrm{Re}_D}$

C. $C_f = \frac{32}{\mathrm{Re}_D}$

D. $C_f = \frac{64}{\mathrm{Re}_D}$

Options :

1. 1
2. 2
3. 3
4. 4

Question Number : 5 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

Consider a steady, fully developed laminar flow of a constant property Newtonian fluid through a circular pipe of diameter D. The velocity profile in the pipe is given by $\frac{v_z}{v_{z,\max}} = \left(1 - \frac{4r^2}{D^2}\right)$, where r is the radial distance from the centreline of the pipe and $v_{z,\max}$ is the maximum velocity which occurs at the pipe centreline. The frictional head losses are expressed in terms of the Darcy friction factor defined by the equation: $h_f = \frac{\Delta p}{\rho g} = f \frac{L}{D} \frac{\bar{v}_z^2}{2g}$, where $\bar{v}_z$ denotes the average velocity of the flow and Δp denotes the pressure drop across a length L of the pipe. The relationship between the Darcy friction factor and the Reynolds number for pipe flow is given by

A. $f = \frac{8}{\mathrm{Re}_D}$

B. $f = \frac{16}{\mathrm{Re}_D}$

C. $f = \frac{32}{\mathrm{Re}_D}$

D. $f = \frac{64}{\mathrm{Re}_D}$

Options :

1. 1
2. 2
3. 3
4. 4

Question Number : 6 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

Consider a steady, fully developed laminar flow of a constant property Newtonian fluid through a circular pipe of diameter D. The velocity profile in the pipe is given by $\frac{v_z}{v_{z,\max}} = \left(1 - \frac{4r^2}{D^2}\right)$, where r is the radial distance from the centreline of the pipe and $v_{z,\max}$ is the maximum velocity which occurs at the pipe centreline. The skin friction coefficient, C_f is defined as $C_f = \frac{|\tau_w|}{\frac{1}{2}\rho \bar{v}_z^2}$ and the Darcy friction factor defined by the equation: $h_f = \frac{\Delta p}{\rho g} = f \frac{L}{D} \frac{\bar{v}_z^2}{2g}$, where $\bar{v}_z$ denotes the average velocity of the flow, τ_w denotes the magnitude of wall shear stress and Δp denotes the pressure drop across a length L of the pipe. The relationship between the Darcy friction factor and the skin friction coefficient is given as

A. $f = C_f$

B. $f = 2C_f$

C. $f = 4C_f$

D. $f = 8C_f$

Options :

1. 1

2. 2

3. 3

4. 4

Question Number : 7 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

Water flows through a pipe having an inner radius of 10 mm at the rate of 36 kg/hr at 25ºC. The viscosity of water at 25ºC is 0.001 kg/(m.s). The Reynolds number of the flow is

A. 636
B. 1272
C. 2544
D. 3816

Options :

1. 1

2. 2

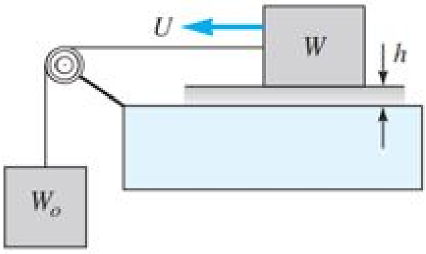
3. 3

4. 4

Question Number : 8 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

A block of weight W is being pulled over a table by another weight W_0, as shown in the figure. The block slides on an oil film of thickness h and viscosity μ. The block bottom area A is in contact with the oil. The cord weight and the pulley friction are negligible. Assuming a linear velocity profile in the oil film, an algebraic formula for the steady velocity U of the block is



A. $\dfrac{Wh}{\mu A}$

B. $\dfrac{W_0 h}{\mu A}$

C. $\dfrac{(W_0 - W)h}{\mu A}$

D. $\dfrac{(W_0 + W)h}{\mu A}$

Options :

1. 1

2. 2

3. 3

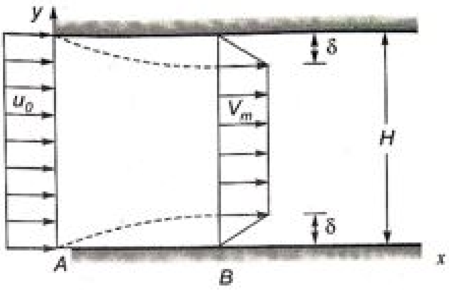
4. 4

Question Number : 9 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

Consider a steady incompressible flow through a channel as shown below. The velocity profile is uniform with a value of u_0 at the inlet section A. The velocity profile at section B downstream is given as

$$u = \begin{cases} V_m \dfrac{y}{\delta}, & 0 \le y \le \delta \\ V_m, & \delta \le y \le H-\delta \\ V_m \dfrac{H-y}{\delta}, & H-\delta \le y \le H \end{cases}$$



The ratio V_m / u_0 is

A. 1

B. $\dfrac{1}{1-2(\delta/H)}$

C. $\dfrac{1}{1+(\delta/H)}$

D. $\dfrac{1}{1-(\delta/H)}$

Options :

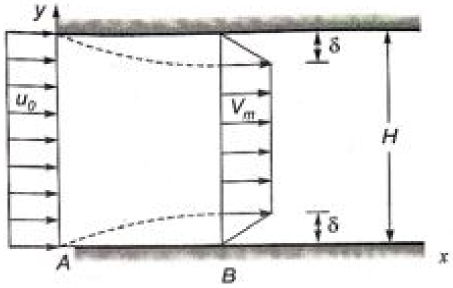
1. 1
2. 2
3. 3
4. 4

Question Number : 10 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

Consider a steady incompressible flow through a channel as shown below. The velocity profile is uniform with a value of u_0 at the inlet section A. The velocity profile at section B downstream is given as

$$u = \begin{cases} V_m \dfrac{y}{\delta}, & 0 \le y \le \delta \\ V_m, & \delta \le y \le H-\delta \\ V_m \dfrac{H-y}{\delta}, & H-\delta \le y \le H \end{cases}$$



The ratio $\dfrac{p_A - p_B}{\frac{1}{2}\rho u_0^2}$ (where p_A and p_B are the pressures at section A and B, respectively, and ρ is the density of the fluid) is

A. $\dfrac{1}{[1-(\delta/H)]^2}$

B. $\dfrac{1}{(1-(\delta/H))^2}-1$

C. $\dfrac{1}{[1-(2\delta/H)]^2}$

D. $\dfrac{1}{(1-(2\delta/H))^2}-1$

Options :

1. 1
2. 2
3. 3
4. 4

Question Number : 11 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

Consider a steady, two-dimensional, incompressible flow over a flat plate at zero angle of incidence with respect to the uniform free stream of velocity U_∞. Assuming the boundary layer theory to be valid, which among the following is the MOST SIMPLIFIED form of the linear momentum equation governing this flow field?

A. $\rho\left(\frac{\partial u}{\partial t}+u\frac{\partial u}{\partial x}+v\frac{\partial u}{\partial y}\right)=-\frac{dp_\infty}{dx}+\mu\frac{\partial^2 u}{\partial y^2}$

B. $\rho\left(u\frac{\partial u}{\partial x}+v\frac{\partial u}{\partial y}\right)=-\frac{dp_\infty}{dx}+\mu\frac{\partial^2 u}{\partial y^2}$

C. $\rho\left(u\frac{\partial u}{\partial x}+v\frac{\partial u}{\partial y}\right)=\mu\frac{\partial^2 u}{\partial y^2}$

D. $\rho\frac{\partial u}{\partial t}=\mu\frac{\partial^2 u}{\partial y^2}$

Options :

1. 1
2. 2
3. 3
4. 4

Question Number : 12 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

Consider a steady, two-dimensional, incompressible flow over a flat plate of length L at zero angle of incidence with respect to the uniform free stream of velocity U_∞. Assuming the boundary layer theory to be valid, which among the following scaling relations between the non-dimensional boundary layer thickness and the Reynolds number, $\mathrm{Re}_L=\frac{\rho U_\infty L}{\mu}$ is correct?

A. $\frac{\delta}{L} : \sqrt{\mathrm{Re}_L}$

B. $\frac{\delta}{L} : \frac{1}{\sqrt{\mathrm{Re}_L}}$

C. $\frac{\delta}{L} : \frac{1}{\mathrm{Re}_L}$

D. $\frac{\delta}{L} : \frac{1}{\mathrm{Re}_L^2}$

Options :

1. 1
2. 2
3. 3
4. 4

Question Number : 13 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

. The laminar boundary layer thickness for flow over a flat plate varies with the distance form the leading edge, denoted by x, as

A. $\sqrt{x}$

B. $\frac{1}{\sqrt{x}}$

C. x^2

D. $\frac{1}{x^2}$

Options :

1. 1
2. 2
3. 3
4. 4

Question Number : 14 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

Consider a steady, two-dimensional, incompressible flow over a flat at zero angle of incidence with respect to the uniform free stream. The boundary layer thickness is 1 mm at a location where the local Reynolds number is 1000. If the free stream velocity of the flow alone is increased by a factor of 4, then the boundary layer thickness at the same location, in mm will be

A. 0.25
B. 0.5
C. 2
D. 4

Options :

1. 1
2. 2
3. 3
4. 4

Question Number : 15 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

Consider laminar flow of water over a flat plate of length 1 m. If the boundary layer thickness at a distance of 0.2 m from the leading edge of the plate is 8 mm, the boundary layer thickness (in mm), at a distance of 0.8 m from the leading edge is

A. 10
B. 12
C. 16
D. 32

Options :

1. 1
2. 2
3. 3
4. 4

Question Number : 16 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

Consider a steady, two-dimensional, incompressible flow over a flat plate at zero angle of incidence with respect to the uniform free stream of velocity U_∞. Assume the boundary layer theory to be valid. Which among the following conditions is satisfied by this flow field?

A. At $y = 0$, $u = 0$

B. At $y = 0$, $u = U_\infty$

C. As $y \to 0$, $\frac{\partial u}{\partial y} \to \infty$

D. None of the above

Options :

1. 1
2. 2
3. 3
4. 4

Question Number : 17 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

Consider a steady, two-dimensional, incompressible flow over a flat plate at zero angle of incidence with respect to the uniform free stream of velocity U_∞. Assume the boundary layer theory to be valid. Which among the following conditions is satisfied by this flow field?

A. As $y \to \infty$, $u \to 0$

B. As $y \to \infty$, $\frac{\partial u}{\partial y} \to 0$

C. As $y \to \infty$, $\mu \frac{\partial u}{\partial y} \to \frac{0.332 \rho U_\infty^2}{\sqrt{\mathrm{Re}_x}}$

D. None of the above

Options :

1. 1
2. 2
3. 3
4. 4

Question Number : 18 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

Consider a steady, two-dimensional, incompressible flow over a flat plate at zero angle of incidence with respect to the uniform free stream of velocity U_∞. Which among the following conditions is satisfied by this flow field?

A. As $y \to 0$, $\frac{\partial u}{\partial y} \to \infty$

B. At $y = 0$, $\frac{\partial^2 u}{\partial y^2} = 0$

C. As $y \to \infty$, $\mu \frac{\partial^2 u}{\partial y^2} \to \frac{0.664 \rho U_\infty^2}{x\sqrt{\mathrm{Re}_x}}$

D. None of the above

Options :

1. 1
2. 2
3. 3
4. 4

Question Number : 19 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

Choose the expression for the displacement thickness, δ^* of the boundary layer for flow over a flat plate

A. $\delta^* = \int_0^\infty \left(1 - \frac{u}{u_\infty}\right) dy$

B. $\delta^* = \int_0^\infty \frac{u}{u_\infty} dy$

C. $\delta^* = \int_0^\infty \frac{u}{u_\infty}\left(1 - \frac{u}{u_\infty}\right) dy$

D. $\delta^* = \int_0^\infty \left(\frac{u}{u_\infty}\right)^2 dy$

Options :

1. 1
2. 2
3. 3
4. 4

Question Number : 20 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

Choose the expression for the momentum thickness, θ of the boundary layer for flow over a flat plate

A. $\theta = \int_0^\infty \left(1 - \frac{u}{u_\infty}\right) dy$

B. $\theta = \int_0^\infty \frac{u}{u_\infty} dy$

C. $\theta = \int_0^\infty \frac{u}{u_\infty}\left(1 - \frac{u}{u_\infty}\right) dy$

D. $\theta = \int_0^\infty \left(\frac{u}{u_\infty}\right)^2 dy$

Options :

1. 1
2. 2
3. 3
4. 4

Question Number : 21 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

Consider a steady, two-dimensional, incompressible flow over a flat plate at zero angle of incidence with respect to the uniform free stream of velocity U_∞. Let δ^* denote the displacement thickness and θ denote the momentum thickness of the boundary layer. x is the axial coordinate along the length of the plate measured from the leading edge. Which among the following equations correctly represents the momentum integral equation for the boundary layer?

A. $\frac{\tau_w}{\rho U_\infty^2} = \frac{d}{dx}\left(\theta + \delta^*\right)$

B. $\frac{\tau_w}{\rho U_\infty^2} = \frac{d}{dx}\left(2\theta + \delta^*\right)$

C. $\frac{\tau_w}{\rho U_\infty^2} = \frac{d\delta^*}{dx}$

D. $\frac{\tau_w}{\rho U_\infty^2} = \frac{d\theta}{dx}$

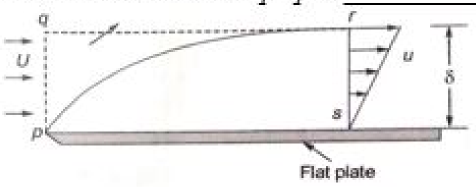
Options :

1. 1
2. 2
3. 3
4. 4

Question Number : 22 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

A fluid of constant density ρ flows over a stationary, smooth flat plate with an incipient free stream velocity U_∞ as shown in the figure. The thickness of the boundary layer at the section r-s is δ. The velocity distribution within the boundary layer is approximated by $\frac{u}{U_\infty} = \frac{y}{\delta}$. The plate width perpendicular to the plane of figures is w. The mass flow rate into the control volume across the section p-q is ________.



A. 0

B. $\frac{\rho U_\infty \delta w}{2}$

C. $\frac{\rho U_\infty \delta w}{4}$

D. $\rho U_\infty \delta w$

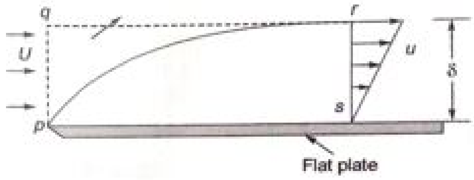
Options :

1. 1
2. 2
3. 3
4. 4

Question Number : 23 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

A fluid of constant density ρ flows over a stationary, smooth flat plate with an incipient free stream velocity U_∞ as shown in the figure. The thickness of the boundary layer at the section *r*-*s* is δ. The velocity distribution within the boundary layer is approximated by $\frac{u}{U_\infty} = \frac{y}{\delta}$. The plate width perpendicular to the plane of figures is *w*. The mass flow rate out of the control volume across the section *r*-*s* is __________.



A. $\rho U_\infty \delta w$

B. $\frac{\rho U_\infty \delta w}{2}$

C. $\frac{\rho U_\infty \delta w}{4}$

D. 0

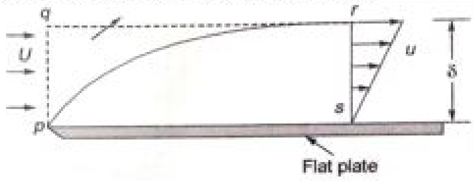
Options :

1. 1
2. 2
3. 3
4. 4

Question Number : 24 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

A fluid of constant density ρ flows over a stationary, smooth flat plate with an incipient free stream velocity U_∞ as shown in the figure. The thickness of the boundary layer at the section *r*-*s* is δ. The velocity distribution within the boundary layer is approximated by $\frac{u}{U_\infty} = \frac{y}{\delta}$. The plate width perpendicular to the plane of figures is *w*. The mass flow rate into of the control volume across the section *p*-*s* is __________.



A. 0

B. $\rho U_\infty \delta w$

C. $\frac{\rho U_\infty \delta w}{2}$

D. $\frac{\rho U_\infty \delta w}{4}$

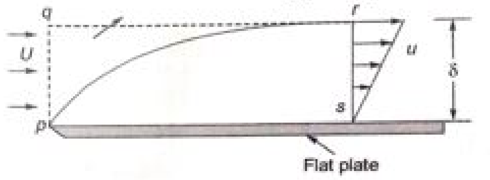
Options :

1. 1
2. 2
3. 3
4. 4

Question Number : 25 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

. A fluid of constant density ρ flows over a stationary, smooth flat plate with an incipient free stream velocity U_∞ as shown in the figure. The thickness of the boundary layer at the section *r-s* is δ. The velocity distribution within the boundary layer is approximated by $\frac{u}{U_\infty} = \frac{y}{\delta}$. The plate width perpendicular to the plane of figures is *w*. The mass flow rate out of the control volume across the section *q-r* is __________.



A. 0

B. $\frac{3\rho U_\infty \delta w}{4}$

C. $\frac{\rho U_\infty \delta w}{2}$

D. $\frac{\rho U_\infty \delta w}{4}$

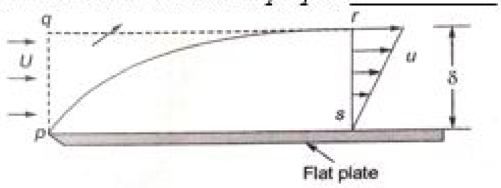
Options :

1. 1
2. 2
3. 3
4. 4

Question Number : 26 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

A fluid of constant density ρ flows over a stationary, smooth flat plate with an incipient free stream velocity U_∞ as shown in the figure. The thickness of the boundary layer at the section *r-s* is δ. The velocity distribution within the boundary layer is approximated by $\frac{u}{U_\infty} = \frac{y}{\delta}$. The plate width perpendicular to the plane of figures is *w*. The momentum flux into the control volume across the section *p-q* is __________.



A. $\rho U_\infty^2 \delta w$

B. $\frac{\rho U_\infty^2 \delta w}{2}$

C. $\frac{\rho U_\infty^2 \delta w}{3}$

D. 0

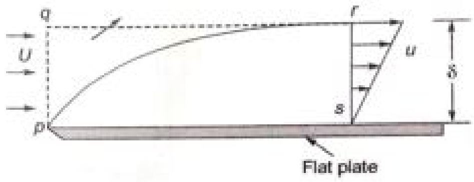
Options :

1. 1
2. 2
3. 3
4. 4

Question Number : 27 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

A fluid of constant density ρ flows over a stationary, smooth flat plate with an incipient free stream velocity U_∞ as shown in the figure. The thickness of the boundary layer at the section r-s is δ. The velocity distribution within the boundary layer is approximated by $\frac{u}{U_\infty} = \frac{y}{\delta}$. The plate width perpendicular to the plane of figures is w. The momentum flux out of the control volume across the section r-s is __________.



A. $\rho U_\infty^2 \delta w$

B. $\frac{\rho U_\infty^2 \delta w}{2}$

C. $\frac{\rho U_\infty^2 \delta w}{3}$

D. 0

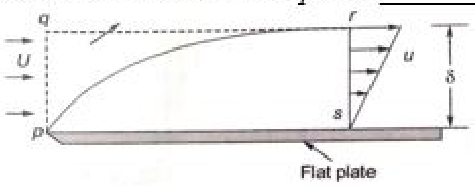
Options :

1. 1
2. 2
3. 3
4. 4

Question Number : 28 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

A fluid of constant density ρ flows over a stationary, smooth flat plate with an incipient free stream velocity U_∞ as shown in the figure. The thickness of the boundary layer at the section r-s is δ. The velocity distribution within the boundary layer is approximated by $\frac{u}{U_\infty} = \frac{y}{\delta}$. The plate width perpendicular to the plane of figures is w. The momentum flux into of the control volume across the section p-s is __________.



A. $\rho U_\infty^2 \delta w$

B. $\frac{\rho U_\infty^2 \delta w}{2}$

C. $\frac{\rho U_\infty^2 \delta w}{3}$

D. 0

Options :

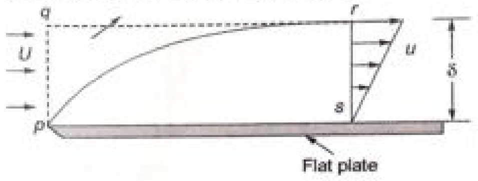
1. 1
2. 2
3. 3

4. 4

Question Number : 29 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

A fluid of constant density ρ flows over a stationary, smooth flat plate with an incipient free stream velocity U_∞ as shown in the figure. The thickness of the boundary layer at the section *r-s* is δ. The velocity distribution within the boundary layer is approximated by $\frac{u}{U_\infty} = \frac{y}{\delta}$. The plate width perpendicular to the plane of figures is *w*. The momentum flux out of the control volume across the section *q-r* is __________.



A. 0

B. $\frac{\rho U_\infty^2 \delta w}{2}$

C. $\frac{\rho U_\infty^2 \delta w}{3}$

D. $\frac{\rho U_\infty^2 \delta w}{6}$

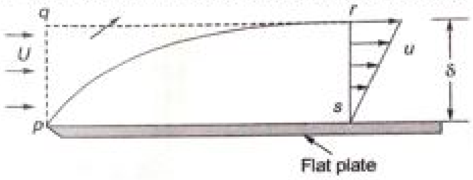
Options :

1. 1
2. 2
3. 3
4. 4

Question Number : 30 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

A fluid of constant density ρ flows over a stationary, smooth flat plate with an incipient free stream velocity U_∞ as shown in the figure. The thickness of the boundary layer at the section *r-s* is δ. The velocity distribution within the boundary layer is approximated by $\frac{u}{U_\infty} = \frac{y}{\delta}$. The plate width perpendicular to the plane of figures is *w*. The magnitude of the drag force exerted by the fluid on the plate is given by __________.



A. $\frac{\rho U_\infty^2 \delta w}{2}$

B. $\frac{\rho U_\infty^2 \delta w}{4}$

C. $\frac{\rho U_\infty^2 \delta w}{3}$

D. $\frac{\rho U_\infty^2 \delta w}{6}$

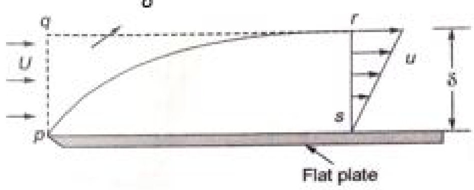
Options :

1. 1
2. 2
3. 3
4. 4

Question Number : 31 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

A fluid of constant density ρ flows over a stationary, smooth flat plate with an incipient free stream velocity U_∞ as shown in the figure. The thickness of the boundary layer at the section *r-s* is δ. The velocity distribution within the boundary layer is approximated by $\frac{u}{U_\infty} = \frac{y}{\delta}$. The plate width perpendicular to the plane of figures is *w*. If δ^* is the local displacement thickness, the value of $\frac{\delta^*}{\delta}$ is



A. $\frac{1}{2}$

B. $\frac{1}{4}$

C. $\frac{1}{3}$

D. $\frac{1}{6}$

Options :

1. 1
2. 2

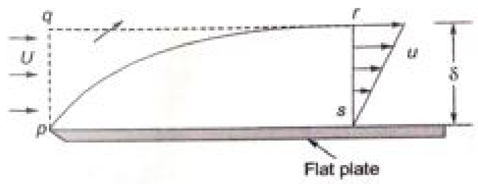
3. 3

4. 4

Question Number : 32 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

A fluid of constant density ρ flows over a stationary, smooth flat plate with an incipient free stream velocity U_∞ as shown in the figure. The thickness of the boundary layer at the section *r*-*s* is δ. The velocity distribution within the boundary layer is approximated by $\frac{u}{U_\infty} = \frac{y}{\delta}$. The plate width perpendicular to the plane of figures is *w*. If θ is the local momentum thickness, the value of $\frac{\theta}{\delta}$ is



A. $\frac{1}{2}$

B. $\frac{1}{4}$

C. $\frac{1}{3}$

D. $\frac{1}{6}$

Options :

1. 1
2. 2
3. 3
4. 4

Question Number : 33 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

Consider a constant property Newtonian fluid that occupies the region above a single, infinite plane boundary. The fluid is initially stationary. Beginning at time *t*=*0,* this boundary oscillates back and forth in its own plane with a velocity $U_0 \cos(\omega t)$. Which among the following is the MOST SIMPLIFIED form of the linear momentum equation governing this flow field?

A. $\rho\left(\frac{\partial u}{\partial t} + u\frac{\partial u}{\partial x} + v\frac{\partial u}{\partial y}\right) = \mu\frac{\partial^2 u}{\partial y^2}$

B. $\rho\left(u\frac{\partial u}{\partial x} + v\frac{\partial u}{\partial y}\right) = \mu\frac{\partial^2 u}{\partial y^2}$

C. $\rho\frac{\partial u}{\partial t} = \mu\frac{\partial^2 u}{\partial y^2}$

D. $\rho\left(\frac{\partial u}{\partial t} + u\frac{\partial u}{\partial x}\right) = \mu\frac{\partial^2 u}{\partial y^2}$

Options :
1. 1
2. 2
3. 3
4. 4

Question Number : 34 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical
Correct Marks : 2 Wrong Marks : 0

Consider a constant property Newtonian fluid that occupies the region above a single, infinite plane boundary. The fluid is initially stationary. Beginning at time *t=0,* this boundary oscillates back and forth in its own plane with a velocity $U_0 \cos(\omega t)$. Which among the following conditions is satisfied by this flow field?

A. At $y = 0$, $u = U_0 \cos(\omega t)$

B. At $y = 0$, $u = U_0 \sin(\omega t)$

C. At $y = 0$, $u = U_0$

D. At $y = 0$, $u = 0$

Options :
1. 1
2. 2
3. 3
4. 4

Question Number : 35 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical
Correct Marks : 2 Wrong Marks : 0

. Consider a constant property Newtonian fluid that occupies the region above a single, infinite plane boundary. The fluid is initially stationary. Beginning at time *t=0,* this boundary oscillates back and forth in its own plane with a velocity $U_0 \cos(\omega t)$. Which among the following conditions is satisfied by this flow field?

A. As $y \to \infty$, $u \to U_0 \cos(\omega t)$

B. As $y \to \infty$, $u \to U_0 \sin(\omega t)$

C. As $y \to \infty$, $u \to U_0$

D. As $y \to \infty$, $u \to 0$

Options :
1. 1
2. 2
3. 3
4. 4

Question Number : 36 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical
Correct Marks : 2 Wrong Marks : 0

Consider a constant property Newtonian fluid that occupies the region above a single, infinite plane boundary. The fluid is initially stationary. Beginning at time *t=0,* this boundary oscillates back and forth in its own plane with a velocity $U_0 \cos(\omega t)$. Which among the following conditions is satisfied by this flow field?

A. At $t = 0$, $u = U_0$ everywhere

B. At $t = 0$, $u = -U_0$ everywhere

C. At $t = 0$, $u = 0$ everywhere

D. None of the above

Options :

1. 1
2. 2
3. 3
4. 4

Question Number : 37 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

An initially stationary infinite flat plate is assumed to begin suddenly translating in its own plane with a velocity U_0 at time *t=0* through an initially stationary unbounded fluid. The flat plate is assumed to occupy the *xz*-plane, with the initially stationary fluid occupying the upper half space, $y > 0$. Which among the following is the MOST SIMPLIFIED form of the linear momentum equation governing this flow field?

A. $\rho \frac{\partial u}{\partial t} = \mu \frac{\partial^2 u}{\partial y^2}$

B. $\rho \left(u \frac{\partial u}{\partial x} + v \frac{\partial u}{\partial y} \right) = \mu \frac{\partial^2 u}{\partial y^2}$

C. $\rho \left(\frac{\partial u}{\partial t} + u \frac{\partial u}{\partial x} + v \frac{\partial u}{\partial y} \right) = \mu \frac{\partial^2 u}{\partial y^2}$

D. $\rho \left(\frac{\partial u}{\partial t} + u \frac{\partial u}{\partial x} \right) = \mu \frac{\partial^2 u}{\partial y^2}$

Options :

1. 1
2. 2
3. 3
4. 4

Question Number : 38 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

An initially stationary infinite flat plate is assumed to begin suddenly translating in its own plane with a velocity U_0 at time $t=0$ through an initially stationary unbounded fluid. The flat plate is assumed to occupy the xz-plane, with the initially stationary fluid occupying the upper half space, $y > 0$. A similarity solution for the velocity field is given as:

$$\frac{u}{U_0} = f(\eta)$$

where $\eta = yt^n$. The value of the exponent n is

A. -2
B. 2
C. $\frac{1}{2}$
D. $-\frac{1}{2}$

Options :

1. 1
2. 2
3. 3
4. 4

Question Number : 39 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

An initially stationary infinite flat plate is assumed to begin suddenly translating in its own plane with a velocity U_0 at time $t=0$ through an initially stationary unbounded fluid. The flat plate is assumed to occupy the xz-plane, with the initially stationary fluid occupying the upper half space, $y > 0$. The velocity at a distance d above the plate at a time t_1 is equal to $\frac{U_0}{2}$. At time t_2 $(> t_1)$ the velocity will be equal to $\frac{U_0}{2}$ at a distance d_2 above the plate. The relation between d_2 and d_1 is

A. $\frac{d_2}{d_1} = \sqrt{\frac{t_2}{t1}}$
B. $\frac{d_2}{d_1} = \sqrt{\frac{t_1}{t_2}}$
C.
D. $\frac{d_2}{d_1} = \left(\frac{t_1}{t_2}\right)^2$
E. $\frac{d_2}{d_1} = \left(\frac{t_2}{t_1}\right)^2$

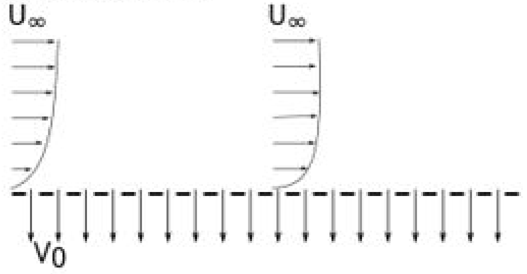
Options :

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

Question Number : 40 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

Fluid flows over a flat plate with a free stream velocity of U_∞ as shown in the figure. Simultaneously fluid is also sucked out of the plate with a uniform velocity V_0. As a result, the velocity profile over the plate does not change with the axial (x) direction. Which among the following is the MOST SIMPLIFIED form of the linear momentum equation governing this flow field?



A. $\rho \frac{\partial u}{\partial t} = \mu \frac{\partial^2 u}{\partial y^2}$

B. $\mu \frac{d^2 u}{dy^2} - \rho V_0 \frac{du}{dy} = 0$

C. $\mu \frac{d^2 u}{dy^2} + \rho V_0 \frac{du}{dy} = 0$

D. $\mu \frac{d^2 u}{dy^2} = 0$

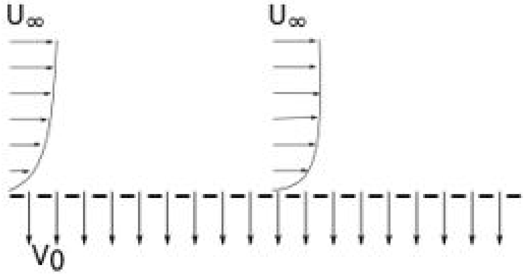
Options :

1. 1
2. 2
3. 3
4. 4

Question Number : 41 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

Fluid flows over a flat plate with a free stream velocity of U_∞ as shown in the figure. Simultaneously fluid is also sucked out of the plate with a uniform velocity V_0. As a result, the velocity profile over the plate does not change with the axial (x) direction. Which among the following conditions is satisfied by this flow field?



A. At $y=0$, $u=U_\infty$ and $v=0$

B. At $y=0$, $u=U_\infty$ and $v=-V_0$

C. At $y=0$, $u=0$ and $v=0$

D. At $y=0$, $u=0$ and $v=-V_0$

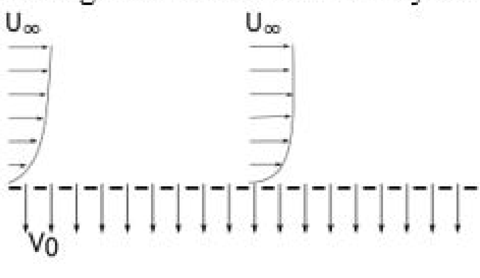
Options :

1. 1
2. 2
3. 3
4. 4

Question Number : 42 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

Fluid flows over a flat plate with a free stream velocity of U_∞ as shown in the figure. Simultaneously fluid is also sucked out of the plate with a uniform velocity V_0. As a result, the velocity profile over the plate does not change with the axial (x) direction. Which among the following conditions is satisfied by this flow field?



A. As $y \to \infty$, $u \to 0$ and $v \to 0$

B. As $y \to \infty$, $u \to 0$ and $v \to -V_0$

C. As $y \to \infty$, $u \to U_\infty$ and $v \to 0$

D. As $y \to \infty$, $u \to U_\infty$ and $v \to -V_0$

Options :

1. 1
2. 2
3. 3
4. 4

Question Number : 43 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

Fluid flows over a flat plate with a free stream velocity of U_∞ as shown in the figure. Simultaneously fluid is also sucked out of the plate with a uniform velocity V_0. As a result, the velocity profile over the plate does not change with the axial (x) direction. Which among the following correctly represents the velocity filed for this flow?

A. $u = U_\infty \exp\left(-\frac{V_0 y}{\nu}\right); \quad v = -V_0$

B. $u = U_\infty \exp\left(-\frac{V_0 y}{\nu}\right); \quad v = 0$

C. $u = U_\infty \left(1 - \exp\left(-\frac{V_0 y}{\nu}\right)\right); \quad v = -V_0$

D. $u = U_\infty \left(1 - \exp\left(-\frac{V_0 y}{\nu}\right)\right); \quad v = 0$

Options :

1. 1
2. 2
3. 3
4. 4

Question Number : 44 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

Fluid flows over a flat plate with a free stream velocity of U_∞ as shown in the figure. Simultaneously fluid is also sucked out of the plate with a uniform velocity V_0. As a result, the velocity profile over the plate does not change with the axial (x) direction. The magnitude of wall shear stress is given by

A. $\rho U_\infty V_0$

B. ρU_∞^2

C. $\frac{0.332 \rho U_\infty V_0}{\sqrt{\text{Re}_x}}$

D. $\frac{0.332 \rho U_\infty^2}{\sqrt{\text{Re}_x}}$

Options :

1. 1
2. 2
3. 3
4. 4

Question Number : 45 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

The predominant forces acting on an element of fluid within the boundary layer over a flat plate in a uniform parallel stream are

A. Viscous and pressure forces
B. Viscous and inertia forces
C. Inertia and pressure forces
D. Viscous and body forces

Options :

1. 1
2. 2
3. 3
4. 4

Question Number : 46 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

For flow past a solid object, flow separation is caused by

A. boundary layer thickness reducing to zero
B. favourable pressure gradient
C. an adverse pressure gradient
D. free stream pressure reducing to the vapour pressure

Options :

1. 1
2. 2
3. 3
4. 4

Question Number : 47 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

At the point of flow separation for flow past a solid object,

A. Wall shear stress is zero
B. Flow velocity is negative i.e. opposite to the free stream velocity
C. Pressure gradient becomes zero
D. Magnitude of wall shear stress reaches a maximum

Options :

1. 1
2. 2
3. 3
4. 4

Question Number : 48 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

Consider the turbulent flow of a Newtonian fluid through a circular pipe of diameter, D. Identify the correct pair of statements.

(i)	The fluid is well-mixed
(ii)	The fluid is unmixed
(iii)	$Re_D < 2300$
(iv)	$Re_D > 2300$

A. (i) and (iii)_
B. (ii) and (iv)
C. (i) and (iv)
D. (ii) and (iii)

Options :

1. 1
2. 2
3. 3
4. 4

Question Number : 49 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

Prandtl's mixing length in a turbulent flow signifies

A. the average distance perpendicular to the mean flow covered by the mixing particles
B. the wavelength corresponding to the lowest frequency present in the flow field
C. the magnitude of turbulent kinetic energy in the units of length
D. the ratio of mean free path to the characteristic length of the flow field

Options :

1. 1
2. 2
3. 3
4. 4

Question Number : 50 Question Type : MCQ Option Shuffling : No Display Question Number : Yes Single Line Question Option : No Option Orientation : Vertical

Correct Marks : 2 Wrong Marks : 0

The instantaneous streamwise velocity of a turbulent flow is given as $u(x,y,z,t)=\overline{u}(x,y,z,t)+u'(x,y,z,t)$. The time average of the fluctuating velocity $u'(x,y,z,t)$ is

A. $\overline{u}$
B. $\frac{\overline{u}}{2}$
C. $-\frac{\overline{u}}{2}$
D. 0

Options :

1. 1
2. 2
3. 3

4. 4