

BITS, PILANI – DUBAI CAMPUS, KNOWLEDGE VILLAGE, DUBAI
SECOND SEMESTER 2006 – 2007
ME UC212 TRANSPORT PHENOMENA – 1
COMPREHENSIVE EXAMINATION DURATION: 180 MINUTES
MAXIMUM MARKS: 40 WEIGHTAGE: 40%

NOTES:

1. Highlight all your answers by enclosing in boxes.
2. Assume any missing data suitably and mention the same at appropriate place in your answer.
3. All the parts of a particular question should be answered together.

1. A semi circular plane of diameter 1.5 m is placed vertically in a fluid of specific weight 8kN/m^3 with its diameter on the free surface. Find the total pressure force and its location. [6M]

2. The rate of shear work per unit volume is given by the product of shear stress, τ and velocity, v . For a parabolic velocity profile in a circular tube, determine the distance from the wall at which the shear work is maximum. [6M]

3. A syphon of uniform diameter of 5cm is used to discharge water from a tank as shown in Figure Q3. For friction less flow, find
 (a) The velocity at A in m/s
 (b) The discharge through the syphon in m^3/s
 (c) Pressure at C in kPa

The maximum length of the pipe BA is controlled by the pressure at which the "cavitation" sets in. In the present case it may be taken as -76.3 kPa . Allowing this limiting value of pressure at point C, find the maximum permissible length for BA. [7M]

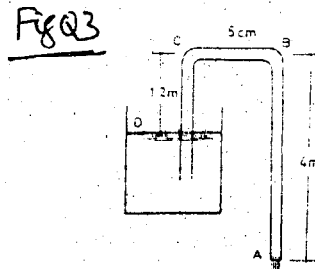
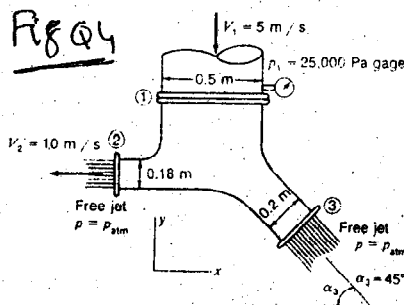
4. Water flows through a double exit elbow, whose configuration is as shown in Figure Q4. The inside volume of the elbow is 1m^3 . Simplifying continuity equation, find the magnitude of v_3 . What are the vertical and horizontal force components from air and water on the elbow? Note that the pressure in the free jets is atmospheric. [7M]

5. The power P to drive an axial pump depends on Density of the fluid, ρ ; Angular speed of the rotor, N ; Diameter of the rotor, D ; Head, H ; Volumetric flow rate, Q . Show that the pump process can be described by three non – dimensional numbers related by

$$\left[\frac{P}{\rho D^5 N^3} \right] = f \left[\left(\frac{H}{D} \right), \left(\frac{Q}{ND^3} \right) \right]$$

Using the above relations, obtain expressions for the variables viz. Head, Discharge and Power of the proto type, in terms of variables relating model and proto type. [7M]

6. Starting from the first principles, derive the 3 – dimensional generalized heat conduction equation in Cartesian coordinates. Simplify the so derived expression for a steady one dimensional conduction heat transfer in the case of a flat plate when the internal heat generation is zero. Hence explain the concept of conductive thermal resistance. [7M]



BITS, PILANI – DUBAI CAMPUS, KNOWLEDGE VILLAGE, DUBAI
SECOND SEMESTER 2006 – 2007
ME UC212 TRANSPORT PHENOMENA – 1
TEST 2 (OPEN BOOK) Date: 13/05/07 DURATION: 50 MINUTES
MAXIMUM MARKS: 20 WEIGHTAGE: 20%

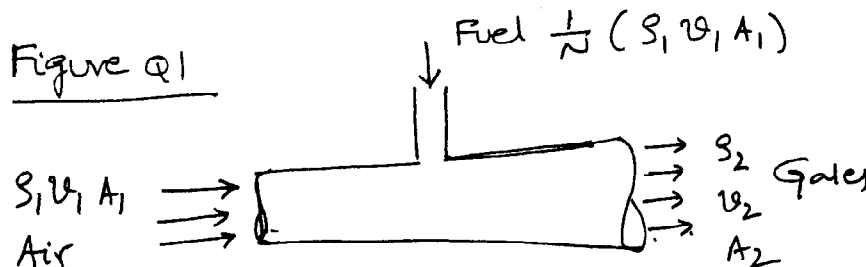
NOTES:

1. Highlight all your answers by enclosing in boxes.
2. Assume any missing data suitably and mention the same at appropriate place in your answer.
3. All the parts of a particular question should be answered together.

1. Figure Q1 shows a highly simplified sketch of a jet engine. The exit velocity is known from other calculations to be V_2 relative to the engine. Furthermore, it is known that $(1/N)$ kilograms of fuel are burnt during operation per kilogram of incoming air where N is a number which depends on the particular engine under consideration. Determine the formula for evaluating the thrust given by the engine. **[8M]**

2. A hydroelectric plant has its inlet 8m above the outlet. Atmospheric Conditions prevail at both inlet and outlet. Inlet and outlet velocities are 3m/s and 8m/s. Simplify the applicable energy equation, clearly writing the reasons for each stage of simplification. Using the simplified energy equation find out the energy given out by each kg of water flowing through the plant. **[8M]**

3. The velocity along the center line of a nozzle of length L is given by $v = 2t \left[1 - \frac{x}{2L} \right]^2$ where v is velocity in m/s, t is time in seconds from commencement of flow and x is distance from inlet to nozzle. Describe the nature of the flow. Find the convective acceleration, local acceleration and total acceleration at $t = 3$ seconds, $x = 0.5$ m, and $L = 0.8$ m. **[4M]**



Name: _____ ID NO: _____ Section: _____

VERSION

A

BITS, PILANI – DUBAI CAMPUS, KNOWLEDGE VILLAGE, DUBAI
SECOND SEMESTER 2006 - 2007

Course: ME UC212 Transport Phenomena – 1

Quiz No :2 (Closed book) Duration: 30 Min Maximum Marks: 10M

1. Select the most appropriate option among the given options and completely cross against that option in the answer sheet.

Example: Option (a) of Question no 21 is represented as

a	b	c	d
<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

2. Incompletely crossed answer blocks; answers marked with modes other than above-mentioned shall be considered as wrong answers.

- The approach in which attention is focused on a particular point or region in space and describes the happenings at that point or within and on the boundaries of the region is
 - Eulerian approach
 - Lagrangian approach
- Water flow through a canal is an example of
 - External fluid flow
 - Open channel fluid flow
 - Critical flow
 - None of the above
- A flow with zero dimensionality is called as
 - Steady flow
 - Unsteady flow
 - Uniform flow
 - None of the above
- Steady flow implies
 - Density is not changing with time
 - Pressure is not changing with time
 - No property is changing with time
 - None of the above.
- A stream line is the imaginary line drawn in such a way that _____ to the line gives the _____ of fluid at that point.
 - Normal; Velocity
 - Tangent; Velocity
 - Tangent; acceleration
 - None of the above
- Stream lines; Streak lines; Path Lines are identical in
 - Uniform flow
 - Unsteady flow
 - Steady flow
 - None of the above
- The curve traced by a single fluid particle during its motion is called as
 - Stream line
 - Path line
 - Streak line
 - Time line
- In a 3 dimensional flow field, expression for stream lines is
 - $\frac{dx}{dv_y} = \frac{dy}{dv_y} = \frac{dz}{dv_y}$
 - $\frac{dx}{dv_x} = \frac{dy}{dv_y} = \frac{dz}{dv_z}$
 - $\frac{dx}{dv_y} = \frac{dy}{dv_x} = \frac{dz}{dv_z}$
 - None of the above
- In the case of an incompressible, steady flow through a pipe with a parabolic velocity profile the average velocity is proportional to
 - Cube of the diameter
 - Square of the diameter
 - Fourth power of diameter
 - Just diameter
- Water enters vertically, through area a with velocity v , in to a control volume. The volumetric flow rate at the entry to be used in simplifying the continuity equation is
 - $-va$
 - va
 - v^2a^2
 - v^3a^3

11. Force acting on a pipe bend due to fluid flow is to be calculated using linear momentum theorem. The external forces to be considered include
- Pressure forces at the entry and exit
 - Body force due to weight of the fluid
 - Both of the above
 - None of the above
12. In the expression for calculating discharge in the case of venturimeter, "h" is
- The pressure rise across entry and throat in meters of flowing liquid
 - The pressure drop across entry and throat in meters of flowing liquid
 - The pressure drop across throat and exit in meters of flowing liquid
 - None of the above
13. In a steady incompressible fluid flow with uniform velocity distribution, the momentum flux in a given x - direction past a given section is expressed as $m_x =$
- ρAv
 - $\frac{\rho v^2}{2}$
 - ρQv_x
 - None of the above
14. No of blades are mounted radially at equal spacing on the periphery of a large wheel. A jet of velocity V is striking the blades as a result of which rotor is rotating with a tangential velocity U. Identify the correct statement from the following
- Mass of the fluid striking the blades is $\rho A(V - U)$ and the effective velocity of the jet is (V - U)
 - Mass of the fluid striking the blades is ρAV and the effective velocity of the jet is (V - U)
 - Mass of the fluid striking the blades is ρAV and the effective velocity of the jet is V
 - None of the above
15. Bernoulli's equation is applicable between any two points in
- Any rotational incompressible flow
 - Steady and incompressible fluid
 - Steady, rotational and viscous fluid flow
 - None of the above
16. The total head is the sum of
- Piezometric head and pressure head
 - Pressure head and datum head
 - Pressure head and velocity head
 - Piezometric head, velocity head
17. For a steady flow, the time dependent term in Continuity equation is
- unity
 - Zero
 - infinity
 - none of the above
18. Coefficient of discharge, for a discharge measuring device such as venturimeter, is defined as
- Actual discharge x Theoretical discharge
 - Actual discharge / Theoretical discharge
 - Actual discharge - Theoretical discharge
 - Actual discharge + Theoretical discharge
19. When a jet is striking an inclined stationary plate, the relationship between the exiting discharges along the tangential direction to the plate, is
- $Q_1 = \frac{Q}{2}(1 + \cos\theta)$ and $Q_2 = \frac{Q}{2}(1 - \cos\theta)$
 - $Q_1 = \frac{Q}{2}(\cos\theta)$ and $Q_2 = \frac{Q}{2}(1 - \cos\theta)$
 - $Q_1 = \frac{Q}{2}(1 + \cos\theta)$ and $Q_2 = \frac{Q}{2}(1/\cos\theta)$
 - None of the above
20. Identify the correct statement in relation to venturimeter
- The Length of converging section is always greater than Diverging section
 - The Length of converging section is always less than Diverging section
 - The Length of converging section is always equal to Diverging section
 - None of the above

Name: _____ ID NO: _____ Section: _____

**VERSION
A**

**BITS, PILANI – DUBAI CAMPUS, KNOWLEDGE VILLAGE, DUBAI
SECOND SEMESTER 2006 - 2007**

Course : ME UC212 Transport Phenomena – 1

Quiz 2 Answer Sheet

Duration: 30 Min

Maximum Marks: 10M

1. Select the most appropriate option among the given options and completely cross against that option in the answer sheet.

Example: Option (a) of Question no 21 is represented as

a	b	c	d
<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

2. Incompletely crossed answer blocks; answers marked with modes other than above-mentioned shall be considered as wrong answers.

Question No	a	b	c	d
1				
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No of correct answers: _____

Marks obtained: _____

Recheck Request: _____

**BITS, PILANI – DUBAI CAMPUS, KNOWLEDGE VILLAGE, DUBAI
SECOND SEMESTER 2006 - 2007**

Course: ME UC212 Transport Phenomena – 1

Quiz No :2 (Closed book) Duration: 30 Min Maximum Marks: 10M

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1. When a jet is striking an inclined stationary plate, the relationship between the exiting discharges along the tangential direction to the plate, is

(a) $Q_1 = \frac{Q}{2}(1 + \cos\theta)$ and $Q_2 = \frac{Q}{2}(1 - \cos\theta)$

(b) $Q_1 = \frac{Q}{2}(\cos\theta)$ and $Q_2 = \frac{Q}{2}(1 - \cos\theta)$

(c) $Q_1 = \frac{Q}{2}(1 + \cos\theta)$ and $Q_2 = \frac{Q}{2}(1/\cos\theta)$

(d) None of the above

2. Identify the correct statement in relation to venturimeter

(a) The Length of converging section is always greater than Diverging section

(b) The Length of converging section is always less than Diverging section

(c) The Length of converging section is always equal to Diverging section

(d) None of the above

3. A flow with zero dimensionality is called as

(a) Steady flow

(b) Unsteady flow

(c) Uniform flow

(d) None of the above

4. Steady flow implies

(a) Density is not changing with time

(b) Pressure is not changing with time

(c) No property is changing with time

(d) None of the above.

5. A stream line is the imaginary line drawn in such a way that _____ to the line gives the _____ of fluid at that point.

(a) Normal; Velocity

(b) Tangent; Velocity

(c) Tangent; acceleration

(d) None of the above

6. In a steady incompressible fluid flow with uniform velocity distribution, the momentum flux in a given x - direction past a given section is expressed as $m_x =$

(a) ρAv (b) $\frac{\rho v^2}{2}$ (c) ρQv_x (d) None of the above

7. No of blades are mounted radially at equal spacing on the periphery of a large wheel. A jet of velocity V is striking the blades as a result of which rotor is rotating with a tangential velocity U. Identify the correct statement from the following

(a) Mass of the fluid striking the blades is $\rho A(V - U)$ and the effective velocity of the jet is (V - U)

(b) Mass of the fluid striking the blades is ρAV and the effective velocity of the jet is (V - U)

(c) Mass of the fluid striking the blades is ρAV and the effective velocity of the jet is V

(d) None of the above

8. For a steady flow, the time dependent term in Continuity equation is

(a) unity

(b) Zero

(c) infinity

(d) none of the above

9. Coefficient of discharge, for a discharge measuring device such as venturimeter, is defined as
- Actual discharge x Theoretical discharge
 - Actual discharge / Theoretical discharge
 - Actual discharge - Theoretical discharge
 - Actual discharge + Theoretical discharge
10. In the case of an incompressible, steady flow through a pipe with a parabolic velocity profile the average velocity is proportional to
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12. Water enters vertically, through area a with velocity v , in to a control volume. The volumetric flow rate at the entry to be used in simplifying the continuity equation is
- $-va$
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19. Bernoulli's equation is applicable between any two points in
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 - Steady and incompressible fluid
 - Steady, rotational and viscous fluid flow
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20. The total head is the sum of
- Piezometric head and pressure head
 - Pressure head and datum head
 - Pressure head and velocity head
 - Piezometric head, velocity head

Name: _____ ID NO: _____ Section: _____

**VERSION
B**

**BITS, PILANI – DUBAI CAMPUS, KNOWLEDGE VILLAGE, DUBAI
SECOND SEMESTER 2006 - 2007**

Course : ME UC212 Transport Phenomena – 1

Quiz 2 Answer Sheet

Duration: 30 Min

Maximum Marks: 10M

1. Select the most appropriate option among the given options and completely cross against that option in the answer sheet.

Example: Option (a) of Question no 21 is represented as

a	b	c	d
<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

2. Incompletely crossed answer blocks; answers marked with modes other than above-mentioned shall be considered as wrong answers.

Question No	a	b	c	d
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No of correct answers: _____

Marks obtained: _____

Recheck Request: _____

BITS, PILANI – DUBAI CAMPUS, KNOWLEDGE VILLAGE, DUBAI
SECOND SEMESTER 2006 – 2007
ME UC212 TRANSPORT PHENOMENA – 1
TEST 1 (CLOSED BOOK) Date: 18/03/06 DURATION: 50 MINUTES
MAXIMUM MARKS: 20 WEIGHTAGE: 20%

NOTES:

1. Highlight all your answers by enclosing in boxes.
2. Assume any missing data suitably and mention the same at appropriate place in your answer.
3. All the parts of a particular question should be answered together.

1. Through appropriate derivation and associated explanation show that, in the non inertial reference plane case of a static fluid, the maximum rate of change of pressure is in the direction of $\vec{g} - \vec{a}$. [4M]

2. Dam ABC shown in Figure Q2 is 30m wide in to the paper. The local acceleration due to gravity is 9.79m/s^2 . Find the following.
 - (a) Hydrostatic force acting on AB.
 - (b) Point of application of the above force.
 - (c) Horizontal and Vertical components of the above force.
 - (d) Net moment produced by the force at point C. [8M]

3. The tank as shown in Figure Q3 is being filled with water by two one dimensional inlets. Air is trapped at the top of the tank. The water height is h . Find an expression for the change in water height dh/dt . Compute the dh/dt if $D_1 = 2.54\text{cm}$, $D_2 = 7.62\text{cm}$, velocity sections 1 and 2 are 0.9144m/s and 0.609m/s respectively, and area of the tank is 0.1858m^2 . [8M]

Figure Q2

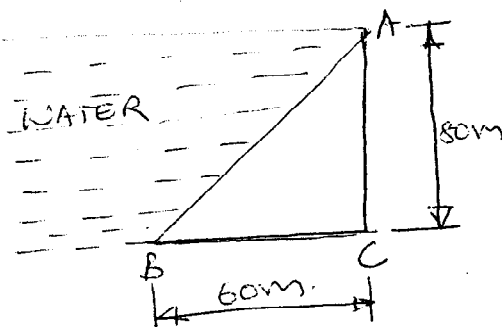
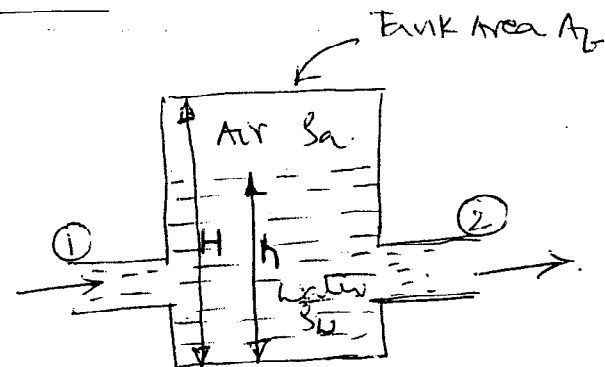


Figure Q3



Name: _____ ID NO: _____ Section: _____

VERSION

A

BITS, PILANI – DUBAI CAMPUS, KNOWLEDGE VILLAGE, DUBAI
SECOND SEMESTER 2006 - 2007

Course No and Name : ME UC212 Transport Phenomena – 1

Quiz No :1 (Closed book) Duration: 30 Min Maximum Marks: 10Marks

1. Select the most appropriate option among the given options and completely cross against that option in the answer sheet.

Example: Option (a) of Question no 21 is represented as

a	b	c	d
<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

2. Incompletely crossed answer blocks; answers marked with modes other than above-mentioned shall be considered as wrong answers.

- Fluid flow can be viewed as
 - The continuous deformation due to tensile stress
 - The continuous deformation due to shear stress
 - The continuous deformation due to compressive stress
 - None of the above
- "A fluid can be incompressible but its flow may be compressible" This statement is
 - True
 - False
- In the case of a static fluid which of the following is either zero or can be neglected.
 - Pressure force
 - All normal forces
 - Shear forces
 - None of the above.
- The transfer phenomena that happens due to temperature difference is
 - Momentum transfer
 - Heat Transfer
 - Mass transfer
 - None of the above
- Gravity force is an example for
 - Body force
 - Pressure force
 - Shear force
 - Frictional force
- In a situation in which the absolute acceleration of a static fluid can not be neglected, the constant pressure lines are
 - In the direction of gravity vector
 - Perpendicular to gravity vector
 - In the direction of acceleration vector
 - None of the above
- In a static fluid, pressure at all points in any horizontal plane is
 - Unity
 - Same
 - Zero
 - None of the above
- "Pressure is equal to the average of the normal tensile stresses". This statement is
 - True
 - False
- The absolute acceleration is zero, in the case of
 - Inertial reference planes
 - Non inertial reference planes
 - Either of the above
 - None of the above
- In the inertial reference plane case, the maximum rate of pressure variation in a static fluid occurs in the direction
 - Perpendicular to gravitational vector
 - Of gravitational vector
 - Of gravitational vector or perpendicular to that direction

- (d) None of the above
11. In a static fluid the forces acting on a fluid element are
 - (a) Gravity forces alone
 - (b) Forces due to Pressure alone
 - (c) Forces due to Gravity and pressure
 - (d) None of the above.
 12. Specific gravity of a the manometric fluid, Mercury is usually equal to
 - (a) 12.6
 - (b) 14.6
 - (c) 13.6
 - (d) 1000
 13. Always the center of pressure and centre of gravity coincide. This statement is
 - (a) True
 - (b) False
 14. The point at which the resultant of all the pressure forces on a submerged surface acts is known as
 - (a) Metacentre
 - (b) Centre of Buoyancy
 - (c) Centre of gravity
 - (d) Centre of Pressure
 15. A hemispherical door is fitted at the bottom corner of a water tank in such a way that the flat portion of the door is in line with the vertical surface of the tank. The vertical force acting the hemispherical door due to water in the tank is equal to
 - (a) Weight of the door
 - (b) $1/3^{\text{rd}}$ of the weight of the door
 - (c) Weight of the water whose volume is equal to the volume of the hemisphere
 - (d) None of the above
 16. When one limb of the simple manometer is connected to a pipe line and the other one is open to the atmosphere, the reading given by the manometer is
 - (a) Ambient pressure
 - (b) Sub zero pressure
 - (c) Gauge pressure
 - (d) None of the above.
 17. In a particular situation a hemispherical object is submerged in a fluid. The area that is considered to find the net horizontal force acting on the surface is
 - (a) Area of circle with half the diameter of sphere
 - (b) Area of circle with diameter equal to diameter of sphere
 - (c) Area of circle with twice the diameter of sphere
 - (d) None of the above
 18. The vertical force acting on a submerged curved surface is equal to
 - (a) Half the weight of the body
 - (b) Twice the weight of the body
 - (c) Half the weight of the volume of the fluid above the surface
 - (d) The weight of the volume of the fluid above the surface
 19. The centre of pressure is directly dependent on
 - (a) Viscosity of the fluid in which the surface is submerged
 - (b) The moment of inertia of the submerged surface
 - (c) Surface tension of the fluid in which the surface is submerged
 - (d) None of the above
 20. The force acting on a plane surface submerged in a fluid is dependent on
 - (a) The position of centre of gravity of the submerged surface from the liquid surface
 - (b) The moment of inertia of the surface
 - (c) Viscosity of the fluid in which the surface is submerged
 - (d) None of the above

Name: _____ ID NO: _____ Section: _____

VERSION
B

BITS, PILANI – DUBAI CAMPUS, KNOWLEDGE VILLAGE, DUBAI
SECOND SEMESTER 2006 - 2007

Course No and Name : ME UC212 Transport Phenomena – 1

Quiz No :1 (Closed book) Duration: 30 Min Maximum Marks: 10Marks

1. Select the most appropriate option among the given options and completely cross against that option in the answer sheet.

Example: Option (a) of Question no 21 is represented as

a	b	c	d
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2. Incompletely crossed answer blocks; answers marked with modes other than above-mentioned shall be considered as wrong answers.

- Gravity force is an example for
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 - Pressure force
 - Shear force
 - Frictional force
- In a situation in which the absolute acceleration of a static fluid can not be neglected, the constant pressure lines are
 - In the direction of gravity vector
 - Perpendicular to gravity vector
 - In the direction of acceleration vector
 - None of the above
- In the inertial reference plane case, the maximum rate of pressure variation in a static fluid occurs in the direction
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 - Of gravitational vector
 - Of gravitational vector or perpendicular to that direction
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- In a static fluid the forces acting on a fluid element are
 - Gravity forces alone
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 - Half the weight of the body
 - Twice the weight of the body
 - Half the weight of the volume of the fluid above the surface

- (d) The weight of the volume of the fluid above the surface
10. The centre of pressure is directly dependent on
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20. A hemispherical door is fitted at the bottom corner of a water tank in such a way that the flat portion of the door is in line with the vertical surface of the tank. The vertical force acting the hemispherical door due to water in the tank is equal to
- Weight of the door
 - $\frac{1}{3}^{\text{rd}}$ of the weight of the door
 - Weight of the water whose volume is equal to the volume of the hemisphere
 - None of the above