Unit 5 - Week 3

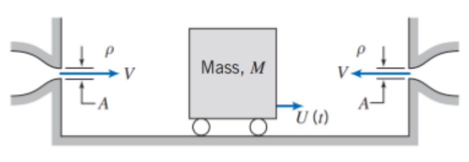
Assignment 3

The due date for submitting this assignment has passed.
As per our records you have not submitted this assignment.

Due on 2019-08-21, 23:59 IST.

1) **Common Data for Questions 1 and 2:** *1 point*

A rectangular block of mass M, with vertical faces, rolls on a horizontal surface between two opposing jets as shown in the figure below. At $t = 0$, the block is set into motion at speed U_0 $(< V)$. Subsequently, it moves without friction parallel to the jet axes with speed $U(t)$. Neglect the mass of any liquid adhering to the block compared with M.



The acceleration of the block at time $t = 0$ is given by

(A) $\left.\frac{dU}{dt}\right|_{t=0} = -\frac{2\rho A\,(V-U_0)^2}{M}$

(B) $\left.\frac{dU}{dt}\right|_{t=0} = -\frac{2\rho A\,(V+U_0)^2}{M}$

(C) $\left.\frac{dU}{dt}\right|_{t=0} = -\frac{2\rho A\,(V^2+U_0^2)}{M}$

(D) $\left.\frac{dU}{dt}\right|_{t=0} = -\frac{4\rho A V U_0}{M}$

- a
- b
- c
- d

No, the answer is incorrect.
Score: 0
Accepted Answers:
d

2) The speed of the block as a function of time, $U(t)$ is given by *1 point*

(A) $U(t) = U_0\left(1 - \frac{4\rho A V}{M}t\right)$

(B) $U(t) = U_0 \exp\left(-\frac{4\rho A V t}{M}\right)$

(C) $U(t) = V - \left(\frac{1}{V-U_0} + \frac{2\rho A}{M}t\right)^{-1}$

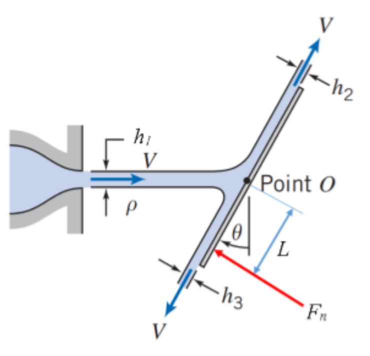
(D) $U(t) = \left(\frac{1}{V+U_0} + \frac{2\rho A}{M}t\right)^{-1} - V$

- a
- b
- c
- d

No, the answer is incorrect.
Score: 0
Accepted Answers:
b

3) **Common Data for Questions 3 and 4:** *1 point*

A liquid jet in the form of a sheet, of thickness h_1 and width w (perpendicular to the plane of the paper), strikes a stationary inclined flat plate as shown in figure below. The liquid jet divides into two streams of equal velocity V (same as that of the oncoming jet), but unequal thickness h_2 and h_3 as shown. For a frictionless flow, the liquid can exert no tangential force F_t on the plate. But the liquid will exert a normal force F_n on the plate by virtue of it's pressure. To hold the plate in equilibrium, an equal and opposite external force need to be applied on the plate at a distance L from the point O, where the jet centerline intersects the plate.



The magnitude of the normal force F_n exerted by the liquid on the inclined plate when $\theta = 45°$ is

(A) $\frac{\rho V^2 h_1 w}{\sqrt{2}}$

(B) $\sqrt{2}\rho V^2 h_1 w$

(C) $\frac{\rho V^2 h_1 w}{2}$

(D) $\frac{\rho V^2 h_1 w}{4}$

- a
- b
- c
- d

No, the answer is incorrect.
Score: 0
Accepted Answers:
a

4) The value of L in terms of h when $\theta = 45°$ is *1 point*

(A) $\frac{h_1}{4}$

(B) $\frac{h_1}{2}$

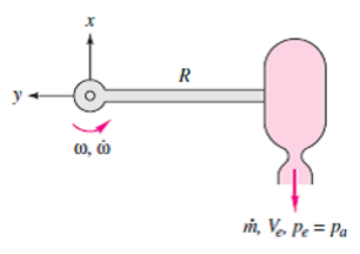
(C) $\frac{h_1}{\sqrt{2}}$

(D) $\sqrt{2}h_1$

- a
- b
- c
- d

No, the answer is incorrect.
Score: 0
Accepted Answers:
b

5) A small rocket is attached to a rigid horizontal rod hinged at the origin as shown in figure below. It has an initial mass M_0 and starts from rest upon ignition at time $t = 0$. Fuel is consumed at a constant rate $\dot{m}$. Exhaust gases leave the exit nozzle at atmospheric pressure with a constant velocity V_e relative to the rocket. Assume uniform flow at the nozzle exit. Also assume that the unburned fuel and the rocket structure have zero momentum relative to the rocket. Neglect gravity, aerodynamic drag, and the rod mass. *1 point*



The angular velocity of the rod as a function of time is given by

(A) $\omega(t) = \frac{\dot{m}V_e t}{M_0 R}$

(B) $\omega(t) = \frac{V_e}{R}\left[1 - \exp\left(-\frac{\dot{m}t}{M_0}\right)\right]$

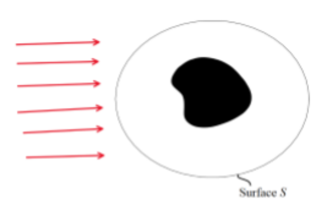
(C) $\omega(t) = -\frac{V_e}{R}\ln\left(1 - \frac{\dot{m}t}{M_0}\right)$

(D) $\omega(t) = \frac{V_e}{R}\left[\exp\left(\frac{\dot{m}t}{M_0}\right) - 1\right]$

- a
- b
- c
- d

No, the answer is incorrect.
Score: 0
Accepted Answers:
c

6) Consider a steady, incompressible flow past an arbitrary solid body in the absence of any body forces. The fluid cannot penetrate the solid body. Consider an arbitrary closed surface S completely surrounding the solid body as shown in the figure below. *1 point*



The hydrodynamic force $\vec{F} = F_i\hat{e}_i$ exerted by the fluid on the solid body is given by

(A) $F_i = \int_S \tau_{ji} n_j \, dS$

(B) $F_i = \int_S \rho u_i (u_j n_j) \, dS$

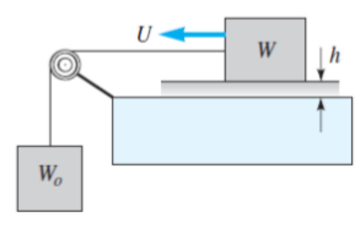
(C) $F_i = \int_S (\tau_{ji} + \rho u_i u_j) n_j \, dS$

(D) $F_i = \int_S (\tau_{ji} - \rho u_i u_j) n_j \, dS$

- a
- b
- c
- d

No, the answer is incorrect.
Score: 0
Accepted Answers:
d

7) A block of weight W is being pulled over a table by another weight W_0, as shown in the figure. Find an algebraic formula for the steady velocity U of the block if it slides on an oil film of thickness h and viscosity μ . The block bottom area A is in contact with the oil. Neglect the cord weight and the pulley friction. Assume a linear velocity profile in the oil film. *1 point*



(A) $\frac{W_0 h}{\mu A}$

(B) $\frac{W h}{\mu A}$

(C) $\frac{(W_0 - W)\,h}{\mu A}$

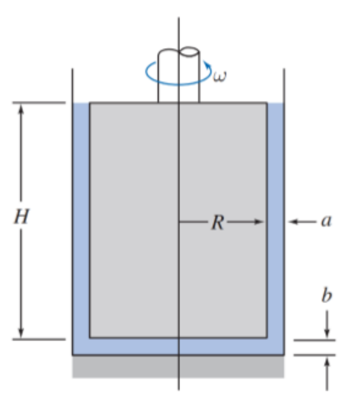
(D) $\frac{(W_0 + W)\,h}{\mu A}$

- a
- b
- c
- d

No, the answer is incorrect.
Score: 0
Accepted Answers:
a

8) **Common Data for Questions 8 and 9 :** *1 point*

A concentric-cylinder viscometer is shown in the figure below. Viscous torque is produced by the annular gap around the inner cylinder. Additional viscous torque is produced by the flat bottom of the inner cylinder as it rotates above the flat bottom of the stationary outer cylinder. Assume a linear velocity profile in the annular gap as well as in the bottom clearance gap between the bottom faces of the inner and outer cylinders.



The viscous torque due to flow in the annular gap of width a is

(A) $\frac{\pi\mu\omega R^3 H}{2a}$

(B) $\frac{\pi\mu\omega R^3 H}{a}$

(C) $\frac{2\pi\mu\omega R^3 H}{a}$

(D) $\frac{4\pi\mu\omega R^3 H}{a}$

- a
- b
- c
- d

No, the answer is incorrect.
Score: 0
Accepted Answers:
c

9) The viscous torque due to flow in the bottom clearance gap of height b is *1 point*

(A) $\frac{\pi\mu\omega R^4}{2b}$

(B) $\frac{\pi\mu\omega R^4}{b}$

(C) $\frac{2\pi\mu\omega R^4}{b}$

(D) $\frac{4\pi\mu\omega R^4}{b}$

- a
- b
- c
- d

No, the answer is incorrect.
Score: 0
Accepted Answers:
a

10) **Assertion (A):** A two-dimensional steady flow field represented by the stream function $\psi = Cxy$, where C is a constant, is an example of an incompressible inviscid flow. *1 point*

Reason (R): The viscous term in the Navier-Stokes equation $\left(\mu\nabla^2\vec{V}\right)$ vanishes identically for this flow filed and therefore the equation of motion reduces to the Euler's equation of motion.

(A) Both A and R are true, and R is the correct explanation of A.

(B) Both A and R are true, but R is not the correct explanation of A.

(C) A is true, but R is false

(D) A is false, but R is true.

(E) Both A and R are false.

- a
- b
- c
- d
- e

No, the answer is incorrect.
Score: 0
Accepted Answers:
d