Unit 12 - Week 10

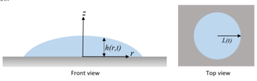
Assignment 10

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

Due on 2019-10-09, 23:59 IST.

1) **Common Data for Questions 1 to 10:** 1 point

A drop of a liquid of constant density ρ and kinematic viscosity ν is allowed to spread on a flat horizontal surface under the action of gravity. The drop spreads in an axisymmetric fashion as shown in the figure below. Use cylindrical coordinates (r, θ, z) for your analysis. Assume the thin film approximations to be valid. Ignore the effects of surface tension and disjoining pressure.



Front view Top view

Let $h(r,t)$ be the thickness of the spreading drop and $L(t)$ be the radius of the spreading drop.

Which among the following is the correct mathematical form of the kinematic boundary condition applicable at the drop surface, $z = h(r,t)$?

(A) $u_z|_{z=h} = \dfrac{\partial h}{\partial t}$

(B) $u_z|_{z=h} = \dfrac{\partial h}{\partial t} + u_r|_{z=h}\dfrac{\partial h}{\partial r}$

(C) $u_z|_{z=h} = 0$

(D) $u_r|_{z=h} = 0$

a
b
c
d

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

2) Which among the following equations is an outcome of the continuity equation? 1 point

(A) $\dfrac{\partial h}{\partial t} + \dfrac{\partial}{\partial r}\left(\int_0^{h(r,t)} u_r \, \mathrm{d}z\right) = 0$

(B) $\dfrac{\partial h}{\partial t} + \dfrac{\partial}{\partial r}\left(\int_0^{h(r,t)} u_r \, \mathrm{d}z\right) = 0$

(C) $\dfrac{\partial h}{\partial t} + \dfrac{1}{r}\dfrac{\partial}{\partial r}\left(r\int_0^{h(r,t)} u_r \, \mathrm{d}z\right) = 0$

(D) $\dfrac{\partial h}{\partial t} + \dfrac{1}{r}\dfrac{\partial}{\partial r}\left(r\int_0^{h(r,t)} u_z \, \mathrm{d}z\right) = 0$

a
b
c
d

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

3) Which among the following are the correct boundary conditions to be satisfied by the horizontal component of velocity, u_r? 1 point

(A) At $z = 0$, $u_r = 0$

(B) At $z = h(r,t)$, $u_r = 0$

(C) At $z = h(r,t)$, $u_r = \dfrac{\partial h}{\partial t}$

(D) At $z = h(r,t)$, $\dfrac{\partial u_r}{\partial z} = 0$

a
b
c
d

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

4) Which among the following is the correct expression for the horizontal component of velocity, u_r within the drop? 1 point

(A) $u_r = -\dfrac{g}{2\nu}\dfrac{\partial h}{\partial r}z(h - z)$

(B) $u_r = -\dfrac{g}{2\nu}\dfrac{\partial h}{\partial r}z(2h - z)$

(C) $u_r = \dfrac{1}{h}\dfrac{\partial h}{\partial t}z$

(D) $u_r = -\dfrac{gh^2}{2\nu}\dfrac{\partial h}{\partial r}\sin\left(\dfrac{\pi z}{h}\right)$

a
b
c
d

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

5) Which among the following is the correct differential equation that governs the evolution of the drop shape as a function of radius r and time t? 1 point

(A) $\dfrac{\partial h}{\partial t} = \dfrac{g}{3\nu r}\dfrac{\partial}{\partial r}\left(rh^2\dfrac{\partial h}{\partial r}\right)$

(B) $\dfrac{\partial h}{\partial t} = \dfrac{g}{12\nu r}\dfrac{\partial}{\partial r}\left(rh^3\dfrac{\partial h}{\partial r}\right)$

(C) $\dfrac{\partial h}{\partial t} = \dfrac{g}{3\nu r}\dfrac{\partial}{\partial r}\left(h\dfrac{\partial h}{\partial r}\right)$

(D) $\dfrac{\partial h}{\partial t} = \dfrac{g}{12\nu}\dfrac{\partial}{\partial r}\left(h^3\dfrac{\partial h}{\partial r}\right)$

a
b
c
d

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

6) The volume of the drop remains conserved during this process of spreading. Which among the following equations correctly represents this volume conservation? 1 point

(A) $8\pi\int_0^{L(t)} h(r,t)\, r^3 \, \mathrm{d}r$=constant

(B) $4\pi\int_0^{L(t)} h(r,t)\, r^2 \, \mathrm{d}r$=constant

(C) $2\pi\int_0^{L(t)} h(r,t)\, r \, \mathrm{d}r$=constant

(D) $\int_0^{L(t)} h(r,t) \, \mathrm{d}r$=constant

a
b
c
d

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

7) Assume a similarity solution: 1 point

$$h(r,t) = \frac{A}{t^m} f(\eta) \text{ with } \eta = \frac{Br}{t^n}$$

for the governing differential equation of Question 5. The value of n is

(A) $\dfrac{1}{2}$

(B) $\dfrac{1}{3}$

(C) $\dfrac{1}{4}$

(D) $\dfrac{1}{5}$

a
b
c
d

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

8) The value of m is 1 point

(A) $\dfrac{1}{2}$

(B) $\dfrac{1}{4}$

(C) $\dfrac{1}{6}$

(D) $\dfrac{1}{8}$

a
b
c
d

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

9) Which among the following are the correct boundary conditions to be satisfied by the function $f(\eta)$? 1 point

(A) At $\eta = 0$, $f = 0$

(B) As $\eta \to \infty$, $f \to 0$

(C) At $\eta = 0$, $\dfrac{\mathrm{d}f}{\mathrm{d}\eta} = 0$

(D) As $\eta \to \infty$, $f \to 1$

a
b
c
d

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

10) Which among the following is the correct relationship between the radius of the spreading drop, $L(t)$ and time t? 1 point

(A) $L(t) \propto t^{1/2}$

(B) $L(t) \propto t^{1/4}$

(C) $L(t) \propto t^{1/8}$

(D) $L(t) \propto t^{1/8}$

a
b
c
d

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