Unit 13 - Week 11

Assignment 11

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

Due on 2020-04-15, 23:59 IST.

1) Which of the following is the correct expression for Reynolds analogy? *1 point*

a. $St = \frac{C_f}{2}$

b. $Nu = Sh$

c. $St = St_m$

d. All of the above.

- a
- b
- c
- d

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

2) For a laminar boundary layer formed on a heated flat plate, with Pr >1, Sc =1, which of the following relations is correct (δ, δ_t, δ_c represents the hydrodynamic, thermal and concentration boundary layer respectively)? *1 point*

a. $\delta > \delta_t$

b. $\delta < \delta_t$

c. $\delta_t > \delta_c$

d. *None*

- a
- b
- c
- d

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

3) Choose the similarity parameters (key dimensionless numbers) for mass transfer *1 point*

a. Re
b. Re, Pr
c. Re, Sc
d. Pr, Sc

- a
- b
- c
- d

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

4) Consider a circular pipe of inner diameter D=0.015m whose inner surface is covered with a layer of liquid water as a result of condensation. In order to dry the pipe, air at 300K and 1atm is forced to flow through it with an average velocity of 1.2m/s and kinematic viscosity (v) = 1.58×10^{-5} m^2/s *2 points*

Using the analogy between the heat and mass transfer, determine the mass transfer coefficient inside the pipe for fully developed flow. (choose the closest value)

Sherwood number relations in mass convection for specified concentration at the surface corresponding to the Nusselt number relations in heat convection for specified surface temperature

Convective Heat Transfer	Convective Mass Transfer
1. *Forced Convection over a Flat Plate*	
(a) Laminar flow ($Re < 5 \times 10^5$)	
$Nu = 0.664\, Re_L^{0.5} Pr^{1/3}$, $Pr > 0.6$	$Sh = 0.664\, Re_L^{0.5} Sc^{1/3}$, $Sc > 0.5$
(b) Turbulent flow ($5 \times 10^5 < Re < 10^7$)	
$Nu = 0.037\, Re_L^{0.8} Pr^{1/3}$, $Pr > 0.6$	$Sh = 0.037\, Re_L^{0.8} Sc^{1/3}$, $Sc > 0.5$
2. *Fully Developed Flow in Smooth Circular Pipes*	
(a) Laminar flow ($Re < 2300$)	
$Nu = 3.66$	$Sh = 3.66$
(b) Turbulent flow ($Re > 10{,}000$)	
$Nu = 0.023\, Re^{0.8} Pr^{0.4}$, $0.7 < Pr < 160$	$Sh = 0.023\, Re^{0.8} Sc^{0.4}$, $0.7 < Sc\ 160$
3. *Natural Convection over Surfaces*	
(a) Vertical plate	
$Nu = 0.59(Gr\,Pr)^{1/4}$, $10^5 < Gr\,Pr < 10^9$	$Sh = 0.59(Gr\,Sc)^{1/4}$, $10^5 < Gr\,Sc < 10^9$
$Nu = 0.1(Gr\,Pr)^{1/3}$, $10^9 < Gr\,Pr < 10^{13}$	$Sh = 0.1(Gr\,Sc)^{1/3}$, $10^9 < Gr\,Sc < 10^{13}$
(b) Upper surface of a horizontal plate	
Surface is hot ($T_s > T_\infty$)	Fluid near the surface is light ($\rho_s < \rho_\infty$)
$Nu = 0.54(Gr\,Pr)^{1/4}$, $10^4 < Gr\,Pr < 10^7$	$Sh = 0.54(Gr\,Sc)^{1/4}$, $10^4 < Gr\,Sc < 10^7$
$Nu = 0.15(Gr\,Pr)^{1/3}$, $10^7 < Gr\,Pr < 10^{11}$	$Sh = 0.15(Gr\,Sc)^{1/3}$, $10^7 < Gr\,Sc < 10^{11}$
(c) Lower surface of a horizontal plate	
Surface is hot ($T_s > T_\infty$)	Fluid near the surface is light ($\rho_s < \rho_\infty$)
$Nu = 0.27(Gr\,Pr)^{1/4}$, $10^5 < Gr\,Pr < 10^{11}$	$Sh = 0.27(Gr\,Sc)^{1/4}$, $10^5 < Gr\,Sc < 10^{11}$

Assume, the mass diffusivity of water vapor in air, $D_{water-air} = 1.87 \times 10^{-10} \frac{T^{2.072}}{P}$

a. 0.00620 m/s

b. 0.00315 m/s

c. 0.0230 m/s

d. 0.0092 m/s

- a
- b
- c
- d

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

5) Linked Questions (5-7) *2 points*

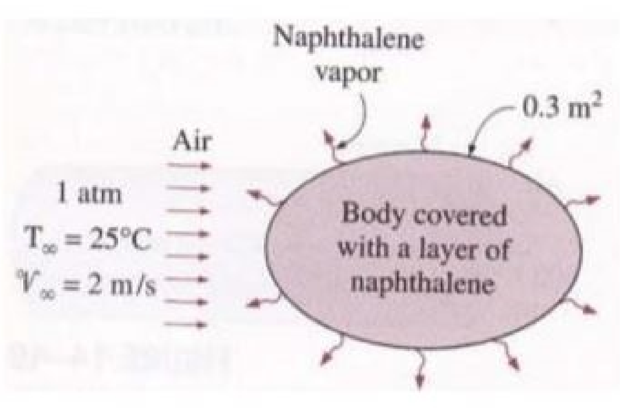
A certain experiment involves the flow of dry air at $25^0 C$ and 1 atm at a free stream velocity of 2 m/s over a body covered with a layer of naphthalene (initial mass = 0.012 kg). It is observed that the naphthalene sublimated in 15 minutes. The surface area of the body is $0.3 m^2$. Both the body and the air were kept at $25^0 C$ during the study. The vapor pressure of naphthalene at 25 °C is 11 Pa and mass diffusivity of naphthalene in air at 25 °C is $D_{AB} = 0.61 \times 10^{-5} m^2/s$.

Given,

Molar Mass of Napthaene = 128.2kg/kmol

Dry air properties of the mixture at $25^0 C$ and 1 atm

$\rho = 1.184 kg/m^3$
$C_p = 1007 J/kg.^\circ C$
$\alpha = 2.141 \times 10^{-5} m^2/s$



Determine the mass fraction of naphthalene at the free stream and at the surface. (Choose the closest value respectively)

a. $0, 4.8 \times 10^{-4}$
b. $4.8 \times 10^{-4}, 0$
c. $0, 2.8 \times 10^{-4}$
d. $0, 6.8 \times 10^{-4}$

- a
- b
- c
- d

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

6) Determine the mass convection coefficient. (Choose the closest value) *2 points*

a. 0.057 m/s
b. 0.078 m/s
c. 0.012 m/s
d. 0.023 m/s

- a
- b
- c
- d

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

7) Using the Chilton-Coulburn analogy find out the heat transfer coefficient. (Choose the closest value) *1 point*

[Hint: $h_{heat} = \rho C_p h_{mass} \left(\frac{\alpha}{D_{AB}}\right)^{2/3}$]

a. 215 $W/m^2\,^\circ C$
b. 100 $W/m^2\,^\circ C$
c. 542 $W/m^2\,^\circ C$
d. 378 $W/m^2\,^\circ C$

- a
- b
- c
- d

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