Unit 4 - Week 2

Course outline

How does an NPTEL online course work?

Prerequisites Assignment

Week 1

Week 2

- Equation of Continuity
- Mass Flux
- Mass and Molar Fluxes
- Shell Balance Approach
- Continuity Equation Approach
- Steady-state Diffusion
- Lecture Notes
- Quiz : Assignment 2
- Weekly Feedback 2 : Transport Phenomena in Biological Systems

Week 3

Week 4

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Assignment Solution

Text Transcripts

Assignment 2

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

Due on 2020-09-30, 23:59 IST.

1) Identify the equation of continuity for a single component mass system *1 point*

- $\frac{\partial \rho}{\partial t} = -(\vec{\nabla}.\rho\vec{v})$
- $\frac{\partial \rho}{\partial t} = (\vec{\nabla}.m\vec{v})$
- $\frac{D\rho}{Dt} = -\rho(\vec{\nabla}.\vec{v})$
- $\frac{Dv}{Dt} = -\rho(\vec{\nabla}.\vec{v})$

No, the answer is incorrect.
Score: 0
Accepted Answers:
$\frac{\partial \rho}{\partial t} = -(\vec{\nabla}.\rho\vec{v})$
$\frac{D\rho}{Dt} = -\rho(\vec{\nabla}.\vec{v})$

2) A bioprocess device is known to show flow characteristics as governed by the equations below. Which of the following statement/s are true? *2 points*

$$v_x = -2a(x+2y^2), v_y = b(2y+x^2-4z^2), v_z = -2c(z^2)$$

- The design of the device is feasible
- The design of the device is not practical
- The design of the device is feasible when (b-a-2cz)=0
- The design of the device is not feasible when (b-a-2cz)=0

No, the answer is incorrect.
Score: 0
Accepted Answers:
The design of the device is not practical
The design of the device is feasible when (b-a-2cz)=0

3) Dalgona coffee is a coffee variety with whipped coffee layer on top of milk. In order for the layer to float on top, the coffee needs to be whipped nicely. In a partially failed attempt to make the coffee, as soon as the whipped coffee is added to the cold milk, the coffee started diffusing to the immediate layer of milk beneath it. If its molar average velocity $\vec{v}^*$ is 6 units across the circular c/s layer and the diffusion velocity of coffee with respect to $\vec{v}^*$ is 9 units (here the downward direction is taken positive), calculate the velocity of the diffusing species with respect to stationary coordinates axes. *1 point*

- 3 units
- 15 units
- 5 units
- 9 units

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

4) In a system with 2 components A and B, at time t=0, 'A' is being diffused into B along x direction starting at x=0, the molecular mass fluxes are represented by j_{Ax} and j_{Bx} respectively. Which of the following statements are true with respect to the above system? ($\forall$ stands for 'for all') *1 point*

- $j_{Ax} = j_{Bx} \; \forall \; t$
- $j_{Ax} + j_{Bx} = 0 \; \forall \; t$
- $j_{Ax} = 0 \; \forall \; x$
- $j_{Ax} \neq j_{Bx} \; \forall \; t$

No, the answer is incorrect.
Score: 0
Accepted Answers:
$j_{Ax} + j_{Bx} = 0 \; \forall t$

5) The relationship between the mass flux and concentrations in a binary mixture is given by *1 point*

- Fick's law
- Newton's law
- Rate law
- Graham's law

No, the answer is incorrect.
Score: 0
Accepted Answers:
Fick's law

6) Moisture content (MC) is an important parameter that is essential in the storage of rice grains. This parameter is mainly affected by the storage temperature and relative humidity. Increased moisture content results in bacterial/fungal attacks and also in insect infestation.
Long term storage of grains in the right quality is essential to ensure continuous supply of grains especially in the times of crisis.
The grains would gain or lose moisture under a set of conditions until an equilibrium is reached. The desired MC for storage of rice grains is below 14% dry weight. A storage facility maintains the rice stocks at a MC of 14%. An unexpected rain in the area increased the relative humidity leading to increased MC of grains. Considering the movement of water across the membrane in one dimension and the gradient in MC between the inside and outside of the grain as the only driving force that increases the MC through diffusion, which among the following do we get as the governing equation if a steady-state material balance is done . Cm- Concentration of water at the membrane, D_{eff} – Effective diffusive coefficient *2 points*

- $\frac{\partial Cm}{\partial t} - D_{eff}\frac{d^2Cm}{dx^2} = 0$
- $D_{eff}\frac{d^2Cm}{dx^2} \neq 0$
- $D_{eff}\frac{d^2Cm}{dx^2} = 0$
- $D_{eff}\left(\frac{d^2Cm}{dx^2} + \frac{d^2Cm}{dy^2}\right) = 0$

No, the answer is incorrect.
Score: 0
Accepted Answers:
$D_{eff}\frac{d^2Cm}{dx^2} = 0$

7) Assuming that the above process of MC gain has reached an equilibrium, identify the expression that best explains this equilibrium state: *1 point*

- $\vec{J}_i^* = \frac{KD_{eff}}{d}$
- $\vec{J}_i^* = 0$
- $\vec{J}_i^* = \frac{K}{d}$
- $\vec{J}_i^* \neq 0$

No, the answer is incorrect.
Score: 0
Accepted Answers:
$\vec{J}_i^* = 0$

8) The moisture gain by grains is also known to occur via diffusion through pores on the membrane. Now, only considering this mode of diffusion through large pores in effect, Identify the equation that best describes permeability 'P' of the membrane with additional resistances. *1 point*

- $P = \left(\frac{D_mK}{d}\right)\left(\frac{\varepsilon}{\tau}\right)$
- $P = \left(\frac{D_mK}{d}\right)\left(\frac{\tau}{\varepsilon}\right)$
- $P = \left(\frac{\tau}{\varepsilon}\right)$
- $P = \left(\frac{D_mK}{d}\right)$

No, the answer is incorrect.
Score: 0
Accepted Answers:
$P = \left(\frac{D_mK}{d}\right)\left(\frac{\varepsilon}{\tau}\right)$

9) Fick's second law gives a relationship between *1 point*

- Rate of change of volume and the concentration gradient
- Rate of change of volume and the concentration gradient
- Rate of change of concentration and the velocity gradient
- Rate of change of concentration and the concentration gradient

No, the answer is incorrect.
Score: 0
Accepted Answers:
Rate of change of concentration and the concentration gradient