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 2020-10-07, 23:59 IST.

1) A silicone tube is used to carry CO_2 to aid a laparoscopic renal surgery. Silicone tube is known to have a higher permeability to CO_2. Assume that the mass transfer occurs only via radial diffusion and there are no convective currents. Identify from below the equation for mass flux through the walls of the tube to the environment given that the thickness of the tube wall is 1/10th the inner diameter and the concentration of CO_2 in the lumen does not vary with time. The concentration of CO_2 in the lumen is Ci. Ri is the inner radius of the lumen.
Hint: Your recall ability is not being evaluated – you are expected to derive from principles. ***2 points***

- $\vec{J}^{*}_{CO_2} = \frac{D_{CO_2 Air^K}}{(C_o - C_i)}$
- $\vec{J}^{*}_{CO_2} = \frac{D_{CO_2 Air^K}(C_o - C_i)}{0.1 + R_i}$
- $\vec{J}^{*}_{CO_2} = \frac{D_{CO_2 Air^K}(C_o - C_i)}{10 R_i}$
- $\vec{J}^{*}_{CO_2} = \frac{D_{CO_2 Air^K}(C_o - C_i)}{0.095 R_i}$

No, the answer is incorrect.
Score: 0
Accepted Answers:
$\vec{J}^{*}_{CO_2} = \frac{D_{CO_2 Air^K}(C_o - C_i)}{0.095 R_i}$

2) A biopolymer composite was developed in a laboratory with desirable properties to deliver the drug to the colon. The developed product was pH responsive. In an experimental setup to analyse its applicability, the drug was infused into the spherical polymer beads and its swelling property was studied in solutions of different pH. If a shell balance approach is used to derive the expression for diffusion of the drug through the beads under steady state, which of the following shells would be the best choice and what would be the boundary conditions at t=0? Given: radius(r)=R, C_{in} = concentration of drug inside the pellet. ***1 point***

- spherical, at t=0, C = C_{in} for 0> r> R
- rectangular c/s of membrane, at t=0, C = 0 for 0> r> R
- spherical, at t=0, C = 0 for r=0
- rectangular c/s of membrane, at t=0, C = C_{in} for r=0

No, the answer is incorrect.
Score: 0
Accepted Answers:
spherical, at t=0, C = C_{in} for 0> r> R

3) At time t > 0 of drug elution, the drug is eluted from the beads in alkaline pH. Identify the boundary condition that represents this phase of drug elution without any resistance from the surroundings ***1 point***

- at t > 0: C=0 at r=0,C=C_∞ at r=R
- at t > 0: $\frac{\partial C}{\partial r}$=0 at r=0,C=0 at r=R
- at t > 0: $\frac{\partial C}{\partial r}$=0 at r=R,C=$C_\infty$ at r=0
- at t > 0: $\frac{\partial C}{\partial r}$=0 at r=0,C=$C_\infty$ at r=R

No, the answer is incorrect.
Score: 0
Accepted Answers:
at t > 0: $\frac{\partial C}{\partial r}$=0 at r=0,C=$C_\infty$ at r=R

4) Animal studies were carried out to test the efficacy of the above biopolymer in drug delivery and to check for unwanted side effects. A drug, which acts in the intestine, was entrapped in the spherical polymer and tested in an animal. The polymer was found to effectively release the drug at the targeted site which is seen through the increase in its bioavailability. This drug once released is known to take part in a reaction of first order kinetics. If we do a steady-state material balance on the spherical biopolymer, which among the following do we get as the governing equation: C_d – Concentration of the drug in the pellet ***2 points***

- $-D_{eff}\left(\frac{d^2C_d}{dr^2} + \frac{2}{r}\frac{dC_d}{dr}\right) = kC_d$
- $-D_{eff}\left(\frac{d^2C_d}{dr^2}\right) = kC_d$
- $-D_{eff}\left(\frac{d^2C_d}{dr^2} + \frac{2}{r}\frac{dC_d}{dr}\right) = \frac{V_m S}{K_m + S}$
- $-D_{eff}\left(\frac{d^2C_d}{dr^2}\right) = 0$

No, the answer is incorrect.
Score: 0
Accepted Answers:
$-D_{eff}\left(\frac{d^2C_d}{dr^2} + \frac{2}{r}\frac{dC_d}{dr}\right) = kC_d$

5) The drug delivery using the above biopolymer had a Thiele modulus of 24.26. As stated previously, the drug takes part in a reaction of first order. Which of the following is true?
Hint: Consider the definition of the Thiele modulus ***1 point***

- Reaction is very slow
- Diffusion of the drug from the biopolymer is very fast
- Reaction is fast but is limited by diffusion
- The polymer may be effective in fast release of the drug

No, the answer is incorrect.
Score: 0
Accepted Answers:
Reaction is fast but is limited by diffusion

6) The ratio of the actual reaction rate to the reaction rate in the absence of mass transfer resistance is termed as ***1 point***

- permeability
- diffusivity
- Thiele modulus
- effectiveness factor

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

7) Which of the following continuity equation denotes an unsteady state diffusion? ***1 point***

- $D_i = \left(\frac{d^2C_i}{dx^2}\right)$
- $D_i = \left(\frac{d^2C_i}{dx^2}\right) = \frac{dC_i}{dt}$
- $\frac{dC_i}{dt} = 0$
- $D_i\left(\frac{dC_i}{dt}\right) = 0$

No, the answer is incorrect.
Score: 0
Accepted Answers:
$D_i = \left(\frac{d^2C_i}{dx^2}\right) = \frac{dC_i}{dt}$

8) Pseudo-steady state approximation is normally used in ***1 point***

- comparing two processes of widely varying rates
- comparing two processes of equal rates
- processes not varying with time
- processes following only zero order kinetics

No, the answer is incorrect.
Score: 0
Accepted Answers:
comparing two processes of widely varying rates

9) A group of microbiologists discovered an endolithic aerobic bacteria. The bacteria survived in the centre of a porous rock. Owing to the fact that the permeability to oxygen was deeply affected by porosity and tortuosity of the rock, the concentration of oxygen inside the rock varied with time. However, the bacteria had adapted itself to the situation over many years by slowing down its metabolism and reproduction rate. Hence the changes in the concentration of oxygen with time did not affect the bacterial metabolism. Now if the diffusion of oxygen to the bacterial cell had to be modelled with an aim to study its growth, which of the following statement/s would be ideal to consider?
C_{o_2}-concentration of oxygen ***1 point***

- $\frac{dC_{o_2}}{dt} \neq 0$ *as pseudo steady state approximation is not possible here*
- $\frac{dC_{o_2}}{dt} = 0$ *inside the rock as pseudo steady state approximation is possible here*
- Oxygen is not needed for bacterial growth
- Modelling is not possible

No, the answer is incorrect.
Score: 0
Accepted Answers:
$\frac{dC_{o_2}}{dt} = 0$ *inside the rock as pseudo steady state approximation is possible here*

10) In the above example, the entry of oxygen in the cell is affected mainly by the permeability of the rock (P_r) and the permeability of the cell membrane (P_c). In the absence of estimates of the above permeabilities, which of the following strategies can be adopted to represent the total permeability (P_t)? ***1 point***

- $\frac{1}{P_t} = \frac{1}{P_r} + \frac{1}{P_c}$
- $\frac{1}{P_t} = \frac{1}{P_r} - \frac{1}{P_c}$
- $\frac{1}{P_t} = \frac{1}{P_c} - \frac{1}{P_r}$
- $\frac{1}{P_t} = \frac{1}{P_r}$

No, the answer is incorrect.
Score: 0
Accepted Answers:
$\frac{1}{P_t} = \frac{1}{P_r} + \frac{1}{P_c}$