編號： 155

國立成功大學 109 學年度碩士班招生考試試題

系　　所：生物醫學工程學系

考試科目：化學反應工程

考試日期：0210，節次：1

※ 考生請注意：本試題可使用計算機。　請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

1. A reaction A + B = Y + Z occurs according to the mechanism:

   $A \underset{k_{-1}}{\overset{k_1}{\rightleftharpoons}} Y$

   $Y + B \xrightarrow{k_2} Z$

   Apply the steady-state treatment and obtain an expression for the rate. To what expressions does the general rate equation reduce if

   (1.1) ***(10%)*** The second reaction is slow, the initial equation is established to be very rapid?

   (1.2) ***(10%)*** The second reaction is very rapid compared with the first reaction in either direction?

2. The dependence of rate constants on temperature over a limited range can usually be represented by an empirical equation proposed by Arrhenius in 1889.

   $k = Ae^{-Ea/RT}$, where R is gas constant (8.314 J K^{-1} mol^{-1}), and T is absolute temperature

   (2.1) ***(10%)*** Please explain what is the meaning of the pre-exponential factor *(A)* and the activation energy *(E_a)*, respectively.

   (2.2) ***(10%)*** The rate constants for the first-order gas reaction $N_2O_5 = 2\ NO_2 + 1/2\ O_2$ are as follows:

T/K	273	298	308	318	328	338
$k/10^{-5}\ s^{-1}$	0.0787	3.46	13.5	49.8	150	487

   What are the values of the activation energy (? kJ mol^{-1}) and the pre-exponential factor

3. A chemical reaction mechanism with or without enzyme catalysis shown as follows. The enzyme (E) binds substrate (S) to produce product (P).

   Spontaneous　　$S \longrightarrow P$

   Catalysed　　$E+S \underset{\text{Binding}}{\rightleftharpoons} ES \xrightarrow[\text{Catalysis}]{} E+P$

   (3.1) ***(10%)*** Please plot out the saturation curve for an enzyme reaction showing the relation between the substrate concentration and reaction rate (*v*) including V_{max} (the enzyme's maximum rate) and K_M (Michaelis-Menten constant).

   (3.2) ***(10%)*** Please derive the equation of enzyme reaction rate ($v_0 = \dfrac{V_{max}[S]}{K_M + [S]}$)

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4. ***(10%)*** Two identical plug flow reactors are used to carry out two gas-phase reactors separately:
   A → 2B
   A → B
   These two reactions have the same rate constant, and the feed conditions are the same in these two reactors. Without deriving any design equation, how do you judge which reactor will achieve the higher conversion.

5. ***(10%)*** For the reaction 3A + B = 2C +D which of the relationship is not true?
   (a) $-d[B]/dt = d[D]/dt$
   (b) $-d[B]/dt = 2\, d[C]/dt$
   (c) $d[C]/dt = 2\, d[D]/dt$
   (d) $-d[A]/dt = 3/2\, d[C]/dt$

6. ***(10%)*** For a second-order reaction A + B → Products with the rate = $k[A][B]$ and initial concentrations $[A]_0 = [B]_0 = a$, calculate the rate coefficient if half of the reactants were reacted in 5 sec.

7. ***(10%)*** Derive the integrated rate equation for a reaction of 1/2 order and then calculate the half-life of such a reaction.