Assignment 3

The due date for submitting this assignment has passed. As per our records you have not submitted this assignment. **Due on 2018-08-22, 23:59 IST.**

1) Free chlorine is mainly present as HOCl, hypochlorous acid in water at pH $< 7.5$. It reacts rapidly ($k_2 = 1.3 \times 10^{-3} \text{ M}^{-1} \text{s}^{-1}$) with bromide ions to form HOBr, hypobromous acid, and Cl$^-$:

$$\text{HOCl} + \text{Br}^- \rightarrow \text{HOBr} + \text{Cl}^-.$$

Ground water at pH = 6.5 is being used for drinking water has a bromide concentration of 65 ppb and is dosed with chlorine to yield a free chlorine residual concentration of 0.5 mg/L as Cl$_2$. What concentration of HOBr reacted in the water in 1 minute of reaction?

- 6.57 x $10^{-7}$ M
- 8.6 x $10^{-7}$ M
- 3.37 x $10^{-7}$ M
- 7.78 x $10^{-7}$ M

No, the answer is incorrect.

Score: 0

Accepted Answers:

- 3.37 x $10^{-7}$ M

2) Oxidation of Fe$^{II}$ within a pH range of 5-9 can be described by the rate equation:

$$-\frac{d[\text{Fe}^{II}]}{dt} = k[\text{Fe}^{II}]P_{O_2}[\text{OH}^-]^2.$$

If the pH and partial pressure of oxygen can be kept constant, the reaction becomes Pseudo First order ($-\frac{d[\text{Fe}^{II}]}{dt} = k_{obs}[\text{Fe}^{II}]$).

The following data on Fe$^{II}$ was obtained in a solution with [OH$^-$] = 1.5 x $10^{-7}$ M and partial pressure of Oxygen at 0.36 atm. What is the value of rate constant $k$ (M$^{-2}$ atm$^{-1}$ min$^{-1}$) for the complete rate equation?

<table>
<thead>
<tr>
<th>Time (min)</th>
<th>0</th>
<th>10</th>
<th>20</th>
<th>30</th>
<th>40</th>
<th>50</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rate (mol/L/min)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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3) The decomposition of $N_2O_5$ in the gas phase was studied at constant temperature.

$$2N_2O_5 \ (g) \rightarrow 4NO_2 \ (g) + O_2 \ (g)$$

The following results were collected:

<table>
<thead>
<tr>
<th>$N_2O_5$ (mol/L)</th>
<th>Time (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1000</td>
<td>0</td>
</tr>
<tr>
<td>0.0707</td>
<td>50</td>
</tr>
<tr>
<td>0.0500</td>
<td>100</td>
</tr>
<tr>
<td>0.0250</td>
<td>200</td>
</tr>
<tr>
<td>0.0125</td>
<td>300</td>
</tr>
<tr>
<td>0.00625</td>
<td>400</td>
</tr>
</tbody>
</table>

The decomposition of $N_2O_5$ was observed to be following first order kinetics. The value of rate constant for the above reaction is

- $7.31 \times 10^{-3} \text{ s}^{-1}$
- $6.93 \times 10^{-3} \text{ s}^{-1}$
- $6.21 \times 10^{-3} \text{ s}^{-1}$
- $5.58 \times 10^{-3} \text{ s}^{-1}$

No, the answer is incorrect.
Score: 0
Accepted Answers:
$6.93 \times 10^{-3} \text{ s}^{-1}$

4) For the above reaction, $[N_2O_5]$ at 150 s after the start of the reaction is

- $0.0433 \text{ mol/L}$
- $0.0334 \text{ mol/L}$
- $0.0375 \text{ mol/L}$
- $0.0353 \text{ mol/L}$

No, the answer is incorrect.
Score: 0
Accepted Answers:
$0.0353 \text{ mol/L}$

5) For the reaction $2X \rightarrow Y$, in which the rate of removal of $X$ follows Second Order Kinetics, $K = \text{Equilibrium Constant}; q = \text{HRT}; MW_x, MW_Y = \text{Molecular weight of} \ X \ \text{and} \ Y \ \text{respectively. Assuming that the reactor is a CSTR, the Mass concentration of} \ Y \ \text{can be expressed as}:

- $Y = Y_0 - (\frac{MW_Y}{2 MW_x}) (\frac{-MW_x + \sqrt{(MW_x^2 + 4kqX_0MW_x)} - 2X_0Kq}{2kq})$ 
- $Y = Y_0 + (\frac{MW_Y}{2 MW_x}) (\frac{-1 + \sqrt{(1 + 4kqX_0)}}{2kq})$ 
- $Y = Y_0 + (\frac{MW_Y}{2 MW_x}) (\frac{-MW_x + \sqrt{(MW_x^2 + 4kqX_0MW_x)} - 2X_0Kq}{2kq})$
6) Bisphenol A (BPA) is used in the production of various plastics and can leach from those plastics into water. It is of concern because it can interfere with the endocrine systems of animals by mimicking the biological activity of estrogen. When BPA is contacted with HOCl, chlorine attacks the aromatic rings to form a variety of reaction products. If the reaction proceeded to equilibrium under conditions typically encountered in disinfection processes, essentially all of the BPA would be destroyed. Thus, as long as any BPA remains, the reaction is far from equilibrium. The reaction can be considered irreversible. What is the time required for destruction of 99% of BPA in a batch reactor for initial concentration of 0.1 µmol/L BPA and 15 µmol/L OCl\(^-\) at pH 7.5? Assume the initial value of OCl\(^-\) is much larger than that of BPA, so that OCl\(^-\) can be considered constant, and the BPA destruction reaction can be considered pseudo-first order. Second order rate constant, \(k_f\) is estimated to be 130 L/(mol·s) at this pH. Assume all the OCl\(^-\) is present as HOCl.

\[
Y = Y_0 - \left( \frac{MW_Y}{2MW_X} \right) \left( -1 + \sqrt{1 + 4kqX_0} \right)/2kq
\]

No, the answer is incorrect.
Score: 0
Accepted Answers:
\[
Y = Y_0 - \left( \frac{MW_Y}{2MW_X} \right) \left( -MW_X + \sqrt{MW_X^2 + 4kqX_0MW_X} \right) - 2X_0Kq)/2kq
\]

7) What will be the ratio of the volume of CSTR to the volume of Plug Flow reactor to achieve 90% reduction in the concentration of a contaminant? Assume that the contaminant removal follows second order kinetics.

\[
\frac{90}{80}\]

No, the answer is incorrect.
Score: 0
Accepted Answers:
10

8) Two separate solutions 1 and 2 were prepared in a research laboratory containing two unknown acids HA and HB respectively and the following observations were made

\[
[A]/[HA] = 3162
\]

pH\(_1\) = 5.5

\[
[B]/[HB] = 1000
\]

pH\(_2\) = 5
Which of them is a stronger acid?

- HA
- HB
- Both have almost same acidic strength
- Insufficient Information

No, the answer is incorrect.
Score: 0
Accepted Answers:
Both have almost same acidic strength

9) The ratio of pKa value of an acid in a solution to its pKa value when the solution is 10 times diluted with distilled water is:

- 0.1
- 1
- 9
- 10

No, the answer is incorrect.
Score: 0
Accepted Answers:
1