"Text" Problems

T10.10 The rate law for a reaction is reported as: rate = k[A][B][C], with the Molar Concentrations in mol/L (M) and the time in seconds. What are the units of k?

T10.15 In a study of the alcohol dehydrogenase catalysed oxidation of ethanol, the Molar concentration decreased in the first-order reaction from 220 mmol/L to 56.0 mmol/L in 1.22x10⁴ s. What is the rate constant of the reaction?

T10.17 In the study of a second-order gas phase reaction, it was found that the Molar concentration of a reactant fell from 220 mmol/L to 56.0 mmol/L in 1.22x10⁴ s. What is the rate constant for the reaction?

T10.31 The reaction 2 A → P has a second-order rate law with k = 1.24x10⁻³ M⁻¹s⁻¹. Calculate the time required for the concentration of A to change from 0.260 mol/L to 0.026 mol/L.

T10.33 The Activation Energy for the decomposition of benzene diazonium chloride is 99.1 kJ/mol. At what temperature will the rate be 10% greater than its rate at 25 °C?

T10.40 The Activation Energy of the first-order decomposition of dinitrogen oxide into N₂ and O is 251 kJ/mol. The half-life of the reactant is 6.5x10⁶ s at 455 °C. What will the half-life be at 550 °C?

Supplementary Home Work Problems

S10.1 The rate law for the reaction, A + B → Products, is of the form, \( r = k[A]^x[B]^y \). From the initial rate data for this reaction given below, determine the reaction orders, “x” and “y”, and the rate constant, k (give units).

<table>
<thead>
<tr>
<th>[A₀] (M)</th>
<th>[B₀] (M)</th>
<th>r₀ (Ms⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.10</td>
<td>2.0</td>
<td>8.50</td>
</tr>
<tr>
<td>0.30</td>
<td>2.0</td>
<td>2.83</td>
</tr>
<tr>
<td>0.30</td>
<td>3.0</td>
<td>7.80</td>
</tr>
</tbody>
</table>
S10.2 The rate of a reaction, \( A \rightarrow \) Products, is second order with respect to \([A]\); i.e. \( \frac{d[A]}{dt} = -k[A]^2 \). When the initial concentration is 0.60 M, it takes 45 seconds for the concentration to decrease to 0.30 M.

(a) Calculate the rate constant for this reaction.
(b) Calculate the concentration, \([A]\), 70 seconds after the start of the reaction.
(c) Calculate the time it takes for \([A]\) to decrease from 0.60 M to 0.15 M.

S10.3 The natural abundance of \(^{14}\text{C}\) in living matter is \(1.1 \times 10^{-12}\) mol %. Radiochemical analysis of an object obtained in an archaeological excavation revealed the \(^{14}\text{C}\) isotopic abundance to be \(7.2 \times 10^{-13}\) mol %. Calculate the age of the object (\(t_{1/2}[^{14}\text{C}] = 5730\) years).

S10.4 The half-life for the decay of \(^{40}\text{K}\)(sol) to \(^{40}\text{Ar}\)(g) is 1.25 billion years.

(b) If a rock is 3.2 billion years old, the ratio, \([^{40}\text{Ar}]/[^{40}\text{K}]\), is:
   (i) 0.75  (ii) 2.85  (iii) 4.90  (iv) 7.25

(b) If the ratio, \([^{40}\text{K}]/[^{40}\text{Ar}] = 0.75\), for a rock, the age of the rock is:
   (i) 0.90 by  (ii) 1.50 by  (iii) 2.45 by  (iv) 4.50 by

S10.5 The reaction, \( A \rightarrow \) Products, is of order “x” with respect to \([A]\); i.e. \( \frac{d[A]}{dt} = -k[A]^x \). When \([A_0] = 0.90\) M, the half-life is 150 seconds. When \([A_0] = 0.30\) M, the half-life is 260 seconds. Calculate the order of the reaction, \(x\).
S10.6 The rate constant for a first order reaction is $1.5 \times 10^{-3}$ s$^{-1}$ at 40 °C and $8.6 \times 10^{-2}$ s$^{-1}$ at 80 °C.
(a) Calculate the Arrhenius parameters, $A$ and $E_a$, for this reaction.
(b) Calculate the rate constant of this reaction at 130 °C.
(c) Calculate the temperature at which the half-life of this reaction is 200 s.

S10.7 The rate constant for a first order reaction was measured as a function of temperature, and the following Arrhenius plot ($\ln(k)$ vs. $1000/T$) was obtained.

Determine the Activation Energy, $E_a$, and Pre-Exponential Factor, $A$, for this reaction.