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AP Chemistry

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Period ____

Kinetics Worksheet #3
Integrated Rate Laws and Half-Life Problems

Ref: Dick Powell, Chemistry Teacher, Arlington, Texas, Personal Communication, July, 2003.

1. The reaction below shows first-order kinetics, and at 32°C the rate constant is 2.8×10^{-2} min^{-1}. What is the half-life in minutes?

$$C_4H_9Cl + H_2O \rightarrow C_4H_9OH + HCl$$

Answer = 24.75 min

$t_{1/2} = \frac{.693}{2.8 \times 10^{-2}} =$ 24.75 min

2. $A \rightarrow B + C$: This reaction is second-order in A. If the initial concentration of A is 0.100 M, the reaction is 20% complete in 40.0 minutes. What is the rate constant value (and units)?

Answer = 0.0625 $M^{-1}min^{-1}$

$[A]_0 = .100\ M$

$[A]_t = .080\ M$

$t = 40.0\ min$

$\frac{1}{.080} = k(40.0) + \frac{1}{.100}$

$2.5 = 40k$

$k = .0625$

3. A particular first-order reaction has a rate constant of 0.33 min^{-1}. How many minutes will it take for a reactant concentration of 0.13 M to decrease to 0.088 M?

Answer = 1.2 min

1st order

$k = .33$

$[A]_0 = .13\ M$

$[A]_t = .088\ M$

$\ln[.088] - \ln[.13] = (-.33)t$

$t = 1.2\ min$

4. The rate law for the hydrolysis of sucrose is Rate = $k[C_{12}H_{22}O_{11}]$. After 2.57 hours at 25° C, 0.55 M of $C_{12}H_{22}O_{11}$ has decreased to 0.45 M. Calculate the rate constant value and units for this reaction.

Answer = 0.078 hr^{-1}

1st order based on rate law in problem

$t = 2.57$ hours

$[A]_o = .55M$

$[A]_t = .45M$

$\ln[.45] - \ln[.55] = -k(2.57)$

$k = .078$

5. The rate constant for the second-order decomposition of nitrogen dioxide, $NO_2 \rightarrow NO + \frac{1}{2} O_2$, is 3.40 M^{-1} min^{-1}. Calculate the time, in minutes, needed to decrease the concentration of NO_2 from 2.00 M to 1.50 M.

Answer = 0.05 minutes

2nd order reaction

$k = 3.40$

$[A]_o = 2.00$ M

$[A]_t = 1.50$ M

$$\frac{1}{1.50} = (3.40)(t) + \frac{1}{2.00}$$

$$.167 = 3.40t$$

$t = .049$ min