CHM152 Quiz 1 25 Pts Fall 2017 Name: Key

Show all Work to Receive Credit

rate = k   rate = k[A]   rate = $k[A]^2$ $[A]_t = -kt + [A]_0$ $\ln[A]_t = -kt + \ln[A]_0$ R= 8.314 J/(mol•K)

$1/[A]_t = kt + 1/[A]_0$ $t_{1/2} = [A]_0/2k$ $t_{1/2} = 0.693/k$ $t_{1/2} = 1/k[A]_0$ $\ln\frac{k_1}{k_2} = \frac{E_a}{R}(\frac{1}{T_2} - \frac{1}{T_1})$ $e=mc^2$

1. (8 Pts) Aspirin, $C_9H_8O_4$, slowly decomposes at room temperature by reacting with water in the atmosphere to produce acetic acid, $HC_2H_3O_2$, and 2-hydroxybenzoic acid, $C_7H_6O_3$ (this is why old bottles of aspirin often smell like vinegar):

$$C_9H_8O_4 + H_2O \rightarrow HC_2H_3O_2 + C_7H_6O_3$$

Concentration and rate data for this reaction are given below.

	$[C_9H_8O_4]$ (M)	$[H_2O]$ (M)	Rate (M/s)
1	0.0100	0.0200	2.4×10^{-13}
2	0.0100	0.0800	9.6×10^{-13}
3	0.0200	0.0200	4.8×10^{-13}

Write the rate law for this reaction and calculate k (be sure to include the correct units).

rate $= k[C_9H_8O_4]^x[H_2O]^y$

For $C_9H_8O_4$ use $\frac{3}{1}$ $\frac{4.8 \times 10^{-13}}{2.4 \times 10^{-13}} = \frac{\cancel{k}}{\cancel{k}}\left(\frac{0.0200}{0.0100}\right)^x \left(\frac{\cancel{0.0200}}{\cancel{0.0200}}\right)^y$

$2 = 2^x$ $x = 1$ (first order)

For H_2O use $\frac{2}{1}$ $\frac{9.6 \times 10^{-13}}{2.4 \times 10^{-13}} = \frac{\cancel{k}}{\cancel{k}}\left(\frac{0.0800}{0.0200}\right)^y$

$4 = (4)^y$ $y = 1$ (first order)

rate $= k[C_9H_8O_4][H_2O]$

$k = \frac{2.4 \times 10^{-13}}{[0.0100][0.0200]} = 1.2 \times 10^{-9}\ M^{-1} \cdot s^{-1}$

2. (2 Pts) Given the rate law for a reaction, rate = $k[A][B]^2$, where rate is measured in units of M s^{-1}, what are the units for the rate constant k?

$k = \frac{M}{s}\frac{}{M \cdot M^2} = M^{-2} \cdot s^{-1}$

3. (5 Pts) A nuclear stress test utilizes a gamma-emitting radioisotope such as thallium-201 to follow the flow of blood through the heart – first at rest, and then under stress. The first-order rate constant for the decay of thallium-201 is 9.5 x 10^{-3} hr^{-1}. Calculate how long it takes for the amount of thallium-201 to fall to 5.0% of its original value.

$\ln\frac{[A]_t}{[A]_0} = -kt$

$\ln\left(\frac{5}{100}\right) = -9.5 \times 10^{-3}\, t$

$t = 315$ hr (320 hr)

— — more on back — —

4. (3 Pts) For the first-order reaction $2N_2O_5 \rightarrow 2N_2O_4 + O_2$ at a particular temperature, the half-life of N_2O_5 is 0.90 hr. Determine the value of the rate constant?

$$t_{1/2} = \frac{\ln 2}{k}$$

$$k = \frac{0.693}{0.90}$$

$$k = 0.77\ \text{hr}^{-1}$$

5. (4 Pts) For the hypothetical reaction $A + 3B \rightarrow 2C$, the rate of appearance of C given by $(\Delta[C]/\Delta t)$ may also be expressed as
   A) $\Delta[C]/\Delta t = \Delta[A]/\Delta t$
   B) $\Delta[C]/\Delta t = -(3/2)\,\Delta[B]/\Delta t$
   C) $\Delta[C]/\Delta t = -(2/3)\,\Delta[B]/\Delta t$
   D) $\Delta[C]/\Delta t = -(1/2)\,\Delta[A]/\Delta t$

$$\text{rate} = \frac{-\Delta[A]}{\Delta t} = \frac{-\Delta[B]}{3\Delta t} = \frac{\Delta[C]}{2\Delta t} = k[A]^x[B]^y[C]^z$$

$$\frac{-\Delta[B]}{3\Delta t} = \frac{\Delta[C]}{2\Delta t}$$

$$\frac{-2\Delta[B]}{3\Delta t} = \frac{\Delta[C]}{\Delta t}$$

6. (3 Pts) The reaction $A + 2B \rightarrow$ products has been found to have the rate law, rate = $k[A][B]^2$. If the concentration of A is tripled and the concentration of B is doubled. Predict by what factor the rate of reaction increases.

rate $k[A][B]^2$

$[3][2]^2 =$ 12 Fold