

\*\*\*Show all work to receive credit\*\*\*

rate = k      rate = k[A]      rate = k[A]<sup>2</sup>      [A]<sub>t</sub> = -kt + [A]<sub>0</sub>      ln[A]<sub>t</sub> = -kt + ln[A]<sub>0</sub>      R = 8.314 J/(mol•K)

1/[A]<sub>t</sub> = kt + 1/[A]<sub>0</sub>      t<sub>1/2</sub> = [A]<sub>0</sub>/2k      t<sub>1/2</sub> = 0.693/k      t<sub>1/2</sub> = 1/k[A]<sub>0</sub>      ln  $\frac{k_1}{k_2} = \frac{E_a}{R} \left( \frac{1}{T_2} - \frac{1}{T_1} \right)$       e=mc<sup>2</sup>

- (5) 1. Chlorine dioxide reacts in basic water to form chlorite and chlorate according to the following chemical equation:



A kinetic study of this reaction under a certain set of conditions yielded the data below.

Exp	[ClO <sub>2</sub> ] (M)	[OH <sup>-</sup> ] (M)	-Δ[ClO <sub>2</sub> ] / Δt (M/s)
1	0.0500	0.100	5.75 x 10 <sup>-2</sup>
2	0.100	0.100	2.30 x 10 <sup>-1</sup>
3	0.100	0.0500	1.15 x 10 <sup>-1</sup>

- a. Determine the rate law for this reaction (find the order of each reactant and write the rate law).

$$\frac{\text{rate 1}}{\text{rate 2}} = \frac{k[\text{ClO}_2]^x [\text{OH}^-]^y}{k[\text{ClO}_2]^x [\text{OH}^-]^y} = \frac{2.30 \times 10^{-1}}{5.75 \times 10^{-2}} = \frac{[0.100]^x}{[0.050]^x}$$

$$\frac{\text{rate 2}}{\text{rate 3}} = \frac{k[\text{OH}^-]^y}{k[\text{OH}^-]^y} = \frac{2.30 \times 10^{-1}}{1.15 \times 10^{-1}} = \left( \frac{0.100}{0.0500} \right)^y$$

4 = 2<sup>x</sup>      x = 2  
2 = (2)<sup>y</sup>      y = 1

$$\text{rate} = k[\text{ClO}_2]^2 [\text{OH}^-]$$

- b. Determine the value of the rate constant and its units.

$$k = \frac{\text{rate}}{[\text{ClO}_2]^2 [\text{OH}^-]} = 230 \text{ M}^{-2} \text{ s}^{-1}$$

- (4) 2. At 25°C the rate constant for the first-order decomposition of a pesticide solution is 6.40 × 10<sup>-3</sup> min<sup>-1</sup>. If the starting concentration of pesticide is 0.0314 M, what concentration will remain after 62.0 min at 25°C?

$$\ln [A]_t = -kt + \ln [A]_0$$

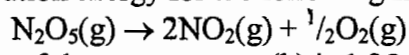
$$\ln [A]_t = -6.40 \times 10^{-3} \text{ min}^{-1} (62.0 \text{ min}) + \ln [0.0314]$$

$$e^{-3.858} = 0.0211 \quad (2.11 \times 10^{-2} \text{ M})$$

- (4) 3. Concerning the rate law, Rate = k[A][B][C], what are appropriate units for the rate constant k?

$$k = \frac{\text{rate}}{[A][B][C]} = \frac{\text{M}}{\text{t} \cdot \text{M} \cdot \text{M}} = \text{M}^{-2} \text{ t}^{-1}$$

(4/4). The activation energy for the following first-order reaction is 102 kJ/mol.



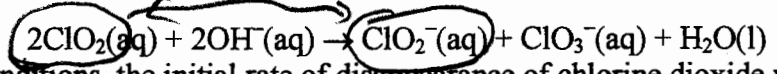
The value of the rate constant (k) is  $1.35 \times 10^{-4} \text{ s}^{-1}$  at  $35^\circ\text{C}$ . What is the value of k at  $0^\circ\text{C}$ ?

$$\ln \frac{k_1}{k_2} = \frac{E_a}{R} \left( \frac{1}{T_2} - \frac{1}{T_1} \right)$$

$$\ln \frac{k}{1.35 \times 10^{-4}} = \frac{102 \times 10^3 \text{ J}}{8.314} \left( \frac{1}{309} - \frac{1}{273} \right) = -5.1067 \dots$$

$$k = 8.2 \times 10^{-7} \text{ s}^{-1}$$

(4)5. Chlorine dioxide reacts in basic water to form chlorite and chlorate according to the following chemical equation:



Under a certain set of conditions, the initial rate of disappearance of chlorine dioxide was determined to be  $2.30 \times 10^{-1} \text{ M/s}$ . What is the initial rate of appearance of chlorite ion under those same conditions?

note 2:1 ratio

$$2.30 \times 10^{-1} \div 2 = 1.15 \times 10^{-1} \text{ M/s}$$

(4)6. The reaction  $\text{A} + 2\text{B} \rightarrow \text{products}$  was found to have the rate law,  $\text{rate} = k[\text{A}][\text{B}]^2$ . Predict by what factor the rate of reaction will increase when the concentration of A is doubled and the concentration of B is also doubled.

$$\text{rate} = k[\text{A}][\text{B}]^2$$

$$[2][2]^2 = 8 \text{ fold increase}$$