

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/(molK)

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

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

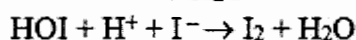
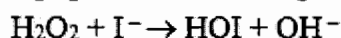
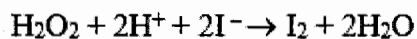
- 1) (5 Pts) A nuclear stress test utilizes a gamma-emitting radioisotope such as thallium-201 to follow the flow of blood through the heart – first at rest, and then under stress. The first-order rate constant for the decay of thallium-201 is $9.5 \times 10^{-3} \text{ hr}^{-1}$. Calculate how long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

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

$$\ln \frac{5}{100} = -9.5 \times 10^{-3} t$$

$$t = 315 \text{ hr} \text{ or } 320 \text{ hrs}$$

- 2) (3 Pts) The following mechanism has been suggested for the reaction:



Slow

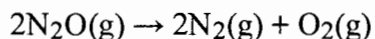
Fast

Fast

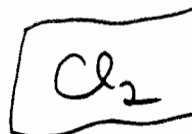
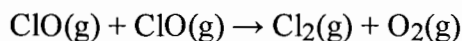
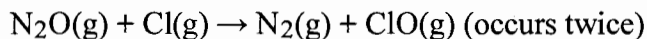
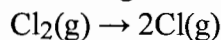
$$\text{rate} = k [\text{H}_2\text{O}_2] [\text{I}^-]$$

Identify a rate law that is consistent with this mechanism.

- 3) (3 Pts) Nitrous oxide (N₂O) decomposes at 600°C according to the balanced equation



A reaction mechanism involving three steps is shown below. Identify all of the catalysts in the following mechanism.



- 4) (6 Pts) The isomerization of cyclopropane follows first order kinetics. The rate constant at 700 K is $6.20 \times 10^{-4} \text{ min}^{-1}$, and the half-life at 760 K is 29.0 min. Calculate the activation energy for this reaction.

Find $k_{\text{at } 760}$: $k = \frac{\ln 2}{t_{1/2}} = 2.39 \times 10^{-2} \text{ min}^{-1}$

$$\ln \frac{6.20 \times 10^{-4}}{2.39 \times 10^{-2}} = \frac{E_a}{8.314} \left(\frac{1}{760} - \frac{1}{700} \right)$$

$$E_a = 265000 \text{ J/mol} \text{ or } 265 \text{ kJ/mol}$$

Key B-2

- 5) (5 Pts) Given that E_a for a certain biological reaction is 48 kJ/mol and that the rate constant is $2.5 \times 10^{-2} \text{ s}^{-1}$ at 15°C , what is the rate constant at 37°C ?

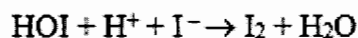
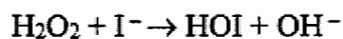
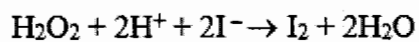
$$15^\circ\text{C} = 288\text{K} \quad 37^\circ\text{C} = 310\text{K}$$

$$\ln \frac{k_2}{2.5 \times 10^{-2}} = \frac{48 \times 10^3 \text{ J/mol}}{8.314 \text{ J/mol}\cdot\text{K}} \left(\frac{1}{288} - \frac{1}{310} \right)$$

$$\ln \frac{k_2}{2.5 \times 10^{-2}} = 1.4226 \dots$$

$$k_2 = 1.0 \times 10^{-1} \text{ s}^{-1}$$

- 6) (3 Pts) The following mechanism has been suggested for the reaction:



Slow

Fast

Fast

Identify all intermediates included in this mechanism.

HOI and OH^-