R = 0.08206 L atm mol⁻¹ K⁻¹ = 8.314 J mol⁻¹ K⁻¹

\[ k = Ae^{-\frac{E_a}{RT}} \]

\[ \ln k = \left(\frac{-E_a}{R}\right) \left(\frac{1}{T}\right) + \ln A \]

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

1. (4 points) The rate constant for the reaction \( \text{CH}_3\text{COOC}_2\text{H}_5 + \text{OH}^- \rightarrow \text{CH}_3\text{COO}^- + \text{C}_2\text{H}_5\text{OH} \)
   is 0.0521 \( M^{-1} s^{-1} \) at 15°C and 0.184 \( M^{-1} s^{-1} \) at 35°C. Calculate the activation energy \( E_a \) for this reaction, in kJ/mol.

\[ \ln \left(\frac{0.184}{0.0521}\right) = \frac{-E_a}{8.314} \left(\frac{1}{308} - \frac{1}{288}\right) \]

\[ 1.22 = -E_a \left(-2.7 \times 10^{-5}\right) \]

\[ E_a = 4.65 \times 10^4 \text{ J/mol} = 46.5 \text{ kJ/mol} \]

2. A reaction proceeds by the following mechanism:

\[ \text{H}_2 + \text{ICl} \rightarrow \text{HI} + \text{HCl} \]

\[ \text{HI} + \text{ICl} \rightarrow \text{HCl} + \text{I}_2 \]

a. (2 points) Write a balanced equation for the overall reaction corresponding to this mechanism.

\[ \text{H}_2 + 2\text{ICl} \rightarrow \text{I}_2 + 2\text{HCl} \]

b. (2 points) Identify the intermediate(s) in the reaction.

\[ \text{H} \text{I} \]

c. (4 points) What is the rate law for the reaction, assuming that the first step is the slowest step?

\[ \text{RATE} = k_1 [\text{H}_2][\text{ICl}] \]

d. (4 points) What is the rate law for the reaction, assuming that the second step is the slowest step?

\[ \text{RATE} = k_2 [\text{HI}][\text{ICl}] \]

\[ \text{INTERMEDIATE} \]

\[ k_1 [\text{H}_2][\text{ICl}] = k_2 [\text{HI}][\text{HCl}] \]

\[ [\text{HI}] = \frac{k_1}{k_2} \cdot \frac{[\text{H}_2][\text{ICl}]}{[\text{HCl}]} \]

\[ \text{OVER} \]

\[ \text{RATE} = \frac{k_1 k_2}{k_1} \cdot \frac{[\text{H}_2][\text{ICl}]^2}{[\text{HCl}]} \]
MULTIPLE CHOICE

3. (2 points) Which of the following is NOT true regarding a catalyst?

a. provides a new mechanism by which reaction can occur
b. lowers the activation energy of the reaction
c. is not a reactant or a product in the balanced overall reaction
đ. shifts the equilibrium so that more product molecules are formed

4. (2 points) The nerve agent sarin operates by

a. inactivating the neurotransmitter acetylcholine
b. inactivating the enzyme (acetylcholinesterase) that destroys acetylcholine
c. blocking the nerve cell receptor to which acetylcholine attaches
d. inhibiting the release of acetylcholine by nerve cells