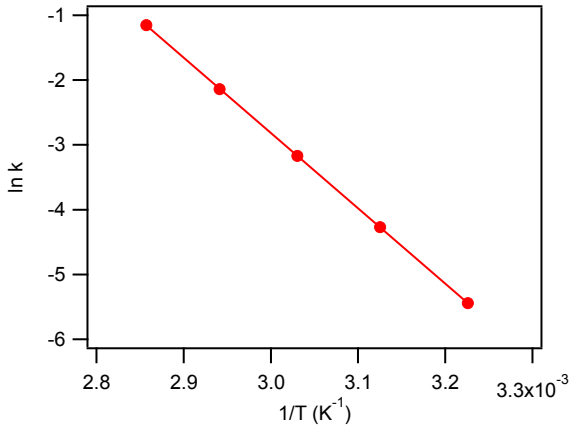
1. Sketch a potential energy versus reaction progress plot for the following reaction:

   $S(s) + O_2(g) \longrightarrow SO_2(g),\ \Delta H_{rxn} = -296\ kJ/mol$

   Label the axes, write the reactants and products in the correct location, label the activation energy (E_a), and label the enthalpy of reaction (ΔH_{rxn}).

2. Given an activation energy of 56.8 kJ/mol and a frequency factor of $1.5 \times 10^{11}\ s^{-1}$, calculate the rate constant of the reaction at 25°C and 50°C.

3. The rate constant for a reaction was measured at several temperatures and an Arrhenius plot was made, shown below. A straight line fit through the data had the following equation: $y = -1.162 \times 10^5 x + 32.06$. Calculate the activation energy and the frequency factor for the reaction.



4. Consider this two-step mechanism for a reaction:

$$NO_2(g) + Cl_2(g) \xrightarrow{k_1} ClNO_2(g) + Cl(g) \quad \text{slow}$$

$$NO_2(g) + Cl(g) \xrightarrow{k_2} ClNO_2(g) \quad \text{fast}$$

   (a) What is the overall reaction?
   (b) Identify any intermediates in the mechanism.
   (c) What is the predicted rate law?

5. Consider the following mechanism:

step 1: $A + B \underset{k_{reverse}}{\overset{k_{forward}}{\rightleftharpoons}} C$ (equilibrium)

step 2: $C + A \xrightarrow{k} D$ (slow)

overall: $2\,A + B \xrightarrow{k'} D$

Determine the rate law for the overall reaction (where the overall rate constant is represented as k.

Note: An intermediate should not appear in the rate law.