The Effect of Temperature on A Reaction

# Introduction

Reaction rate is temperature dependent, and the mathematical form of the dependence is the same as the Clausius-Clapeyron equation:

where k is the rate constant, A0 is called the frequency factor, Ea is the activation energy, R is the gas constant, and T is the temperature measured in Kelvin.

In this experiment, we will perform the iodate-bisulfite reaction at five different temperatures. Since the concentrations of the reactants are always the same, the rate constant will be proportional to the rate. Since the initial concentration of the bisulfite ion is fixed, the rate is inversely proportional to the time of the reaction. Therefore, a plot of ln(1/t) versus (1/T) should be a straight line. The slope of the line can be used to find the activation energy and the intercept can be used to determine the frequency factor.

The Arrhenius equation can be rearranged to give an equation that can be used to find activation energy from two experiments. You find the rate constant, *k*, at two different temperatures, then do some algebra to cancel out variables you don't need.

 (2)

If the rate constant *k1* is known at temperature *T1* and *k2* at *T2*, then the equation can be solved for the activation energy, *Ea.*

# Materials and Methods

0.1 M sodium bisulfite, Na2S2O5

0.1 M potassium iodate, KIO3

5.0 M acetic acid buffer

Starch solution

Hot water and cold water baths

Thermometer or temperature probe

# Procedure

1. Create a water bath in a 250 mL beaker using cold tap water. Add 2.0 mL of iodate solution and 1.0 mL of buffer to one test tube; and 2.0 mL of bisulfite solution and 1.0 mL of starch solution to another.
2. Put both test tubes in the water bath. Wait a few minutes for the temperatures to equalize then record the temperature of the bath with a thermometer or temperature probe. Mix the two solutions and record the time of the reaction.
3. Use a hot plate to increase the temperature of the water bath by at least five degrees. Remove the bath from the hot plate and repeat the procedure.
4. Continue to collect reaction times as a function of temperature. A series of times between 15–40 Celsius would be ideal, although if the reaction time is one second or less then the data will be too inaccurate to be useful.

# Data and Results

1. For each trial, calculate the reaction rate using the equation:



1. Plot the reaction rate on the y-axis versus the temperature, in Kelvins, on the x-axis.
2. Plot the log of the reaction rate on the y-axis versus the inverse temperature (1/K) on the x-axis.
3. Fit the data for the second plot to a straight line and determine the slope.
4. Calculate the activation energy by multiplying the slope by 8.314 J/mol-K.