



CALIFORNIA STATE SCIENCE FAIR 2015 PROJECT SUMMARY

Name(s)

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Project Number

35608

Project Title

The Pink Catalyst

Abstract

Objectives/Goals

To show how catalysts affect the kinetics of a chemical reaction.

Methods/Materials

100-mL of 0.21M potassium sodium tartrate was added into a 500-mL beaker which was then warmed on a hot plate to 70°C. Simultaneously, 0.4g of cobalt chloride was added to 10-mL of distilled water in a 50-mL beaker and stirred until homogeneous. Once the potassium sodium tartrate solution reaches 70°C a 6% hydrogen peroxide solution was added to the 500-mL beaker. At this point reaction is very slow. To facilitate the reaction, the cobalt chloride solution was added to the reaction. The reaction proceeds at a faster rate indicated by the rapid production of carbon dioxide.

Results

The solution starts out pink due to the color of the cobalt chloride catalyst. The solution turns green forming an intermediate between the catalyst and sodium tartrate. The solution returns to the original pink color confirming that a catalyst does not get used up in a chemical reaction. Based on experimental findings, the following reactions can be suggested as taking place in the Co(II)-H₂O₂-tartaric acid system. On the action of hydrogen peroxide, the cobalt (II)-tartrate becomes oxidized to a green, probably binuclear, Co(III) tartrate compound. This cobalt (III)- tartrate is reduced both by tartrate acid and hydrogen peroxide to Co(II)- tartrate with a concomitant evolution of CO₂ and O₂ respectively. Since the color of the solution is green throughout the reaction, and most of the cobalt is present as Co(III), then the first step (oxidation) is most likely faster than the reduction of Co(III)- complex. This also demonstrates kinetics- the effect of temp or the rate of a chemical reaction. For each 10 °C increase in temp., the reaction rate will approximately double. The reaction was timed at various temps. Suggested temps and their corresponding reaction times are the following: 50 °C- 200 sec; 60 °C- 90 sec; 70 °C- 40 seconds.

Conclusions/Discussion

The two reagents, potassium sodium tartrate and hydrogen peroxide, are involved in a redox reaction. A redox reaction is when electrons are exchanged between molecules, here potassium sodium tartrate loses an electron and hydrogen peroxide gains an electron. The speed of the reaction is slow without a catalyst. To speed up this reaction, cobalt (II) salts was added. This causes the reaction to proceed more readily because the cobalt ion is more reactive than the two reagents.

Summary Statement

How catalysts affect the kinetics of a chemical reaction.

Help Received

Used the lab at Seebach Family Chemistry and Physics lab at Ribet Academy under the supervision of Mr. John Shirajian