



**CALIFORNIA STATE SCIENCE FAIR
2014 PROJECT SUMMARY**

Name(s) Tian Chen; Anna Tsai; Ore Ziskind	Project Number J1807
Project Title The Thermodynamic Freezing Paradox of the Mpemba Effect	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals The Mpemba Effect is a phenomenon that seems to contradict the laws of thermodynamic. This effect suggests that warm water freezes faster than cold water. The purpose of this experiment is to determine which of the many theories have the strongest argument towards the cause of the Mpemba effect. Each of the four theories would be tested with different procedures to show the credibility. The documents that supports each theory should be closely examined, to help understand the different variables in their experiment.</p> <p>Methods/Materials If the freezing of water, is determined by the temperature of the water then the sample with the room temperature water would freeze first, according to Newton law of cooling. In order to prove supercooling, 1/4 gram of charcoal dust is added to the water to spark nucleation. To prove the theory for evaporation, the experiment is conducted in a closed container to prevent water vapor from escaping. To prove dissolved gasses, boiled water will be cooled down to normal temperature, then it will be tested again. To prove thermo-conductivity and bond energy transfer in the water, we will have to set up a heat capacity equation to see if the theory have an effect on the Mpemba Effect. The temperature and time of freezing would be recorded. After 9.7 hours take the samples out and observe their crystal formation and physical appearance. Do this test 8 times to make sure the experiment is consistent.</p> <p>Results Observations from the data graph showed that supercooling is not a crucial part of the Mpemba effect. Although not completely ruling out supercooling, there was not enough evidence to support this theory. This theory was tested using air tight beakers, and with air that can not escape, warm water still froze faster than the water kept at room temperature, thus, showing evaporation was not a important part of the Mpemba effect. Lastly, based on observation and mathematical analysis, the most likely theory is thermal conduction and bond energy transfer.</p> <p>Conclusions/Discussion The results yielded does show that the Mpemba Effect does exist and does not contradict newtons law of cooling. We found that supercooling, evaporation, and dissolved gasses noes not have an effect on the Mpemba Effect. The equations showed it is most likely that the Mpemba Effect is caused by bond-energy transfer that leads to thermo-conduction in the system leading to hot water freezing faster than cold water.</p>	
Summary Statement Finding conclusive proof with supporting evidence to the cause of the Mpemba Effect.	
Help Received Advised by: Dr. S L Lee, Ms. C. Degregorio Edited by: Prof. Aleksandr B. Djuristic, Ms. Cameron Most, Mr. Julian Rovee Supervised by: Ms. Meiyong Song	