



**CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY**

Name(s) Alexander Woodside	Project Number S0630
Project Title Quenching Low Carbon Steel	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals The goal of my project was to discover if it was possible to harden low carbon steel by exchanging the quenching medium.</p> <p>Methods/Materials In my project I tested four different quenching mediums to see if it was possible to harden low carbon steel. In order for a steel to harden, the steel needs to cool very quickly. Oil and water are traditional quenching mediums. When quenching in water, a steam envelope forms around the hot steel. My goal was to reduce the steam envelope so that the steel could cool faster. I chose salt water and a Deep Hardening Solution, which; reduces the steam to a nominal quantity. The steel was at the correct temperature to quench when it is no longer magnetic. After quenching, I tested how hard the steel became. I used a blacksmith technique called the file test. If the the file skates across the steel then the steel is hard enough for tool use. I will conduct ten trials per quenching mediums: vegetable oil, distilled water, salt water, and a Deep Hardening Solution.</p> <p>Results The basis of my hypothesis was salt would decrease the steam envelope. This was true, but did not affect the steel as I predicted. The decrease in the steam envelope impaired the water's ability to absorb heat. As a result the steel was not hardened. Steam was almost nonexistent when I quenched in the Deep Hardening Solution. It took a very long time for the steel to cool in the Deep Hardening Solution. When I quenched in the vegetable oil, all the signs of a successful quench were present. The oil absorbed the heat quickly and the steel cooled quickly. Unfortunately, the steel did not harden very well. It actually produced the softest steel of the experiment. In the end, distilled water produced the hardest steel sample.</p> <p>Conclusions/Discussion I must conclude that low carbon steel cannot be hardened by the methods I tested. Portions of some test samples were hardened because of the increased carbon content. My hardest sample (distilled water, trial 7) was not close to passing the file test. I have determined carbonized low carbon steel or mild steel are the best alternatives to high carbon steel. Mild steel has mid-range carbon content. It will produce a semi-hardened tool and would be much easier to carbonize. In the end, low carbon steel by itself is too difficult to harden.</p>	
Summary Statement This project provides data for steel manipulation by the quenching process.	
Help Received I would like to thank everyone around me for their constant support and advice. I thank my Mom, Dad, and Grandfather for all their help and advice.	