



**CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY**

Name(s) Emily A. Hsi	Project Number J2111
Project Title How to Remove Ink Stains	
Objectives/Goals My project identified substances that removed ballpoint, gel, and highlighter ink stains, and tested the impact of immediate treatment, wash time delay, and multiple washes.	
Abstract Methods/Materials For each ink stain (ballpoint, gel, highlighter), 7 substances (bleach, lemon juice, Shout remover, nail polish remover (acetone), hand sanitizer (ethyl alcohol), skim milk, and detergent) plus control were studied in 4 trials which varied immediate stain treatment (Y/N) and wash delay time (8h vs 2d with pre-treatment). Each trial assessed the impact of a second wash. A stain assessment scale (0-10) was created. Each trial had 30 iterations to detect a 1-unit difference in stain score with 88% power at $P \leq 0.05$. Cotton shirts (24) were cut into 120 sections. Each section had 8 quarter-sized stains per ink type, and was treated per assignment. Stains were photographed and scored after each intervention step. Average stain scores were compared across substances using one-way ANOVA tests. Fisher's Exact tests compared the proportion of completely removed stains.	
Results For ballpoint ink, the lowest average residual stain scores were with hand sanitizer (0.1) and nail polish remover (0.3). Complete removal was best achieved with hand sanitizer with immediate treatment, short wash delay (8h) and double washing. Gel ink was completely removed by bleach in any scenario (0.0), but an equivalent alternative was to immediately treat with either hand sanitizer (0.0) or Shout (0.0) with a short wash delay and double wash. Any wash removed highlighter, but lemon juice made it disappear without washing.	
Conclusions/Discussion Hand sanitizer completely removed ballpoint and gel ink with immediate treatment, a short wash delay, and double washing. Alternatives for removing gel ink were Shout remover or bleach (white clothes only). Lemon juice made highlighter stains disappear without washing. Limitations included potential cross contamination when washing 5 shirt sections per load.	
Summary Statement Although alternatives exist, hand sanitizer is a safe and readily available substance that completely removes ballpoint and gel ink with early application and washing.	
Help Received I conceived of the project, researched substances to test, and conducted all experiments, but I received training on one-way ANOVA tests and sample size calculations from my mother (Dr. Susan Huang, Professor of Medicine, UC Irvine).	