
Coffee To Go

Note: This projected is adapted from *Writing Projects for Mathematics Courses* by Annalisa Crannell, Gavin LaRose, Thomas Ratliff, and Elyn Rykken, published by the Mathematical Association of America.

Starburst Coffee
101 Coffee Lane
Palo Alto, CA 94305

Calculus B Students
Kenyon College
Gambier, OH 43022

Dear Calculus B Students:

After the verdict against one of our competitors a few years ago, my company, which ones a series of coffee establishments, has been hit with a series of copy-cat lawsuits. We need some technical expertise on one of these matters, and your enterprising and resourceful professor referred me to you.

The plaintiff, whom I will refer to as R. Clumsy for legal reasons, was the passenger in an automobile that stopped at one of our drive-thru windows early one morning for coffee. Mr. Clumsy placed the coffee in a cup holder for a short time, and then he spilled the coffee. He maintains that the coffee was much too hot, and he is suing for \$200,000 for emotional distress and dry cleaning bills.

I would like to know how credible his story is. While we do serve our coffee at 160°F, I do not believe that the coffee was above the industry standard of 140°F when Mr. Clumsy spilled his coffee. He claims that it was exactly 7:58 a.m. when the coffee was poured, and when he spilled the coffee, some of it fell on his watch, which stopped at precisely 8:08 a.m. He says that he left the coffee in the cup holder for 5 minutes, and held it in his hands for another 5 minutes before spilling it. I would like to be able to raise a reasonable doubt about the credibility of his story, either by showing that the temperature was *not* above the industry standard, or by showing that if the times are slightly different than he claims, then the coffee was not too hot.

Assuming Mr. Clumsy's scenario is correct, I would like to know if the temperature of the coffee was above the industry standard when he spilled it. I am doubtful that he remembered the times exactly. In particular, I seriously doubt that the coffee was in the cup holder and in his hands for *exactly* five minutes. What would the temperature be if the breakdown were 4 minutes in the cup holder and 6 minutes in his hands? 6 minutes in the cup holder and 4 minutes in his hands? 7 minutes in the cup holder and 3 minutes in his hands? I am also a little dubious about his claim that the coffee was poured at 7:58 a.m. exactly. What would the result be if

the coffee were poured at 7:56 a.m. instead? In your report, I would like your expert opinion on whether or not there exists a reasonable doubt that the coffee was above $140^{\circ}F$.

To help you out, the top investigators in our Fact Finding Department have uncovered the following information. Mr. Clumsy lives 7.8 miles away from the coffee shop, so you can assume that the passenger compartment of the car had warmed to a comfortable $72^{\circ}F$. Further, if you take a fresh, delicious, aromatic cup of our delicious coffee and place it in a room at $72^{\circ}F$, then it will cool to $149^{\circ}F$ in four minutes and thirty seconds. We also asked Mr. Clumsy to hold a thermometer in his hands just like he held the coffee. We discovered that the temperature was $92.3^{\circ}F$.

In your report, please clearly describe and explain your methods and results, keeping in mind that your audience (a coffee shop owner) is not a mathematical expert. In particular, you must describe any physical laws that you use, and derive any models or equations that you use for the temperature of the coffee as a function of time (even if you have already derived those models in your Calculus B class). Please include any graphs, charts, or tables that you think might make your exposition more clear. You can export graphs in Maple as .jpeg or .gif files to include in your report by right-clicking on the graphs. Your report must be typed, but you can hand-write mathematical equations in your report if you wish. If you type your report in Microsoft Word, you can use the Equation Editor to type equations. You may also type your report in Maple (please see me if you have questions about how to do this). You may work in teams of up to three students on this project. Your report is due by 5:00 p.m. on Friday, March 21, 2008. The report will be worth 10% of your final grade in this course, and you will be graded both on mathematical clarity and the quality of your written exposition.