



California Science Center  
**CALIFORNIA STATE SCIENCE FAIR**  
**2001 PROJECT SUMMARY**

<b>Your Name</b> (List all student names if multiple authors.) <b>Zachary P. Grieman</b>	<b>Science Fair Use Only</b>  <h1 style="margin: 0;">S0405</h1>
<b>Project Title</b> (Limit: 120 characters. Those beyond 120 will be ignored. See pg. 9) <b>Comparing the Absorption of Light by Sunscreens with Different SPF Values</b>	<b>Division</b> _ Junior (6-8) <u>X</u> Senior (9-12)
<b>Preferred Category</b> (See page 5 for descriptions.) <b>4 - Chemistry</b>	
<b>Abstract</b> (Include Objective, Methods, Results, Conclusion. See samples on page 14.) Use no attachments. Only text inside these boxes will be used for category assignment or given to your judges.	
<p><b>Objective:</b> The objective was to determine if a quantitative relationship exists between a sunscreen's absorptivity of uv light and its SPF value. Another objective was to determine which functional group of the molecules that are the active ingredients in the sunscreens are responsible for the strong absorption of uv light.</p> <p><b>Materials and Methods:</b> Spectra from 225 nm to 400 nm were taken of solutions of sunscreens with SPF values of 4, 8, 15, 30, and 45 to determine absorptivity maxima in this region. Absorptivity maxima of sunscreens were plotted versus the SPF values and log of the SPF values. To determine whether a quantitative relationship exists, a statistical analysis by linear regression was carried out. Spectra were also taken of the active ingredients in sunscreens as well as model molecules with individual functional groups identical to the functional groups in the active ingredient molecules. Spectra intensities were compared to determine which functional group is responsible of the strong uv absorption.</p> <p><b>Results:</b> The linear fit of the plot of absorptivity maxima versus SPF yielded a slope of 0.202 g-cm/L with a standard deviation of 0.073 g-cm/L (36%), and R squared of 0.72, which isn't very close to the desired value of one. The linear fit of the plot of absorptivity maxima versus the log (SPF) yielded a slope of 9.16 g-cm/L, with a standard deviation of 1.50 g-cm/L (16%, much closer to the desirable 0%), and an R squared value of 0.93 much closer to one. None of the model molecules (toluene, acetone, propanol) absorbed enough uv light to be the functional group causing absorption. A spectrum of para aminobenzoic acid (PABA), which combines several functional groups was also taken and showed a strong absorption similar to the active ingredients.</p> <p><b>Conclusions:</b> First, because the linear regression of absorptivity maxima vs. the log of SPF shows a low standard deviation of the slope and an R squared really close to 1, a quantitative relationship between the two quantities is demonstrated to exist. As a result expensive human testing of SPF values could be replaced by spectrometry. Second, PABA proved that the right combination of functional groups (benzene ring, carbonyl, and hydroxyl groups) causes strong absorption of uv light similar to that observed in sunscreens.</p>	
<b>Summary Statement</b> (In one sentence, state what your project is about.) Obtaining and analyzing absorption spectra of sunscreens proved a quantitative relationship exists between absorptivity maxima and SPF values and proved as well which functional groups are responsible for the strong absorption of uv light.	
<b>Help Received in Doing Project</b> (e.g. Mother helped type report; Neighbor helped wire board; Used lab equipment at university X under the supervision of Dr. Y; Participant in NSF Young Scholars Program) See Display Regulation #8 on page 4. Used lab equipment at Pomona College under supervision of Dr. Grieman	