

Your name: \_\_\_\_\_

1. Assuming the sun is indeed behaving as a blackbody, take its temperature. No, seriously. If you go to our course web page (see the syllabus) you will find a link to the National Renewable Energy Laboratory:

<http://rredc.nrel.gov/solar/standards/>

There you will find tabular data indicating the intensity of the electromagnetic radiation emitted by the sun as a function of wavelength, under both AM0 and AM1.5 conditions. Use this data as intelligently as you can to estimate the blackbody temperature required to obtain the best fit possible to the spectral data (you decide which is the "best" set or subset of the data to use – explain the rationale behind your choice). The *relative number* of photons of wavelength  $\lambda$  emitted by a blackbody of temperature T (and thus arriving at any point some distance away if none are absorbed) is given by the blackbody distribution equation:

$$J_{\text{photon,blackbody}}(\lambda) = \frac{2\pi c}{\lambda^4} \left( \frac{1}{e^{hc/\lambda kT} - 1} \right)$$

- $J(\lambda)$  is the *number* of photons given off by a blackbody; the spectral data provided by NREL is in terms of the relative "spectral irradiance," which has units of  $\text{W}\cdot\text{m}^{-2}\cdot\text{nm}^{-1}$ . This is a measure of power, not a count of photons, and so unless you wish to compare apples to oranges, you will have to use what you know about the energy of a photon of wavelength  $\lambda$  in order to convert the spectral data and the equation above into the same units. Either figure out how many photons the sun spits at us as a function of  $\lambda$ , or convert  $J(\lambda)$ , above, into a relative spectral irradiance.
- Determine the blackbody temperature that provides the best match to the spectral data you've decided is appropriate. Explain in words what you used as the basis of this assessment, don't just give me the number and a big spreadsheet or workbook.
- How close does theory match up with reality? Provide a plot of your best fit blackbody spectrum and the actual spectral data, on the same plot. Look up a value for the "temperature of the sun" (whatever that means...be careful to state your assumptions!) and see how it compares to your calculated value.

Hints: This question intentionally leaves a lot to you to figure out. I recommend using a computer program like Excel, KaleidaGraph, or Mathematica to find the best fit. You may well need some help from me...this may be your first non-linear, multivariate curve fit. I'm happy to teach you how to use any of the programs I've mentioned in order to do something like this.

You'll have to understand the spectral irradiance data and the form in which it is provided. It'll help to read the information NREL provides in and around their data pages.

I'll clue you in to a theme generally applicable to this course, and to "real" science: you will have to use a mixture of common sense and rigorous math to do a good job! Keep in mind the question you are trying to answer, and squeeze the available data to get the most out of it you possibly can. It's a tricky thing to learn, but a valuable skill!

Remember to act like a scientist and consider the uncertainty in your data. If you give me a temperature out to 15 decimal places, I'll be very cross. Don't toy with me like that. I'm liable to leave the refrigerator door open, run with scissors, and leave all the lights in the house on. No, seriously. Don't try and stop me, I'll take you down with me. I'm a madman.

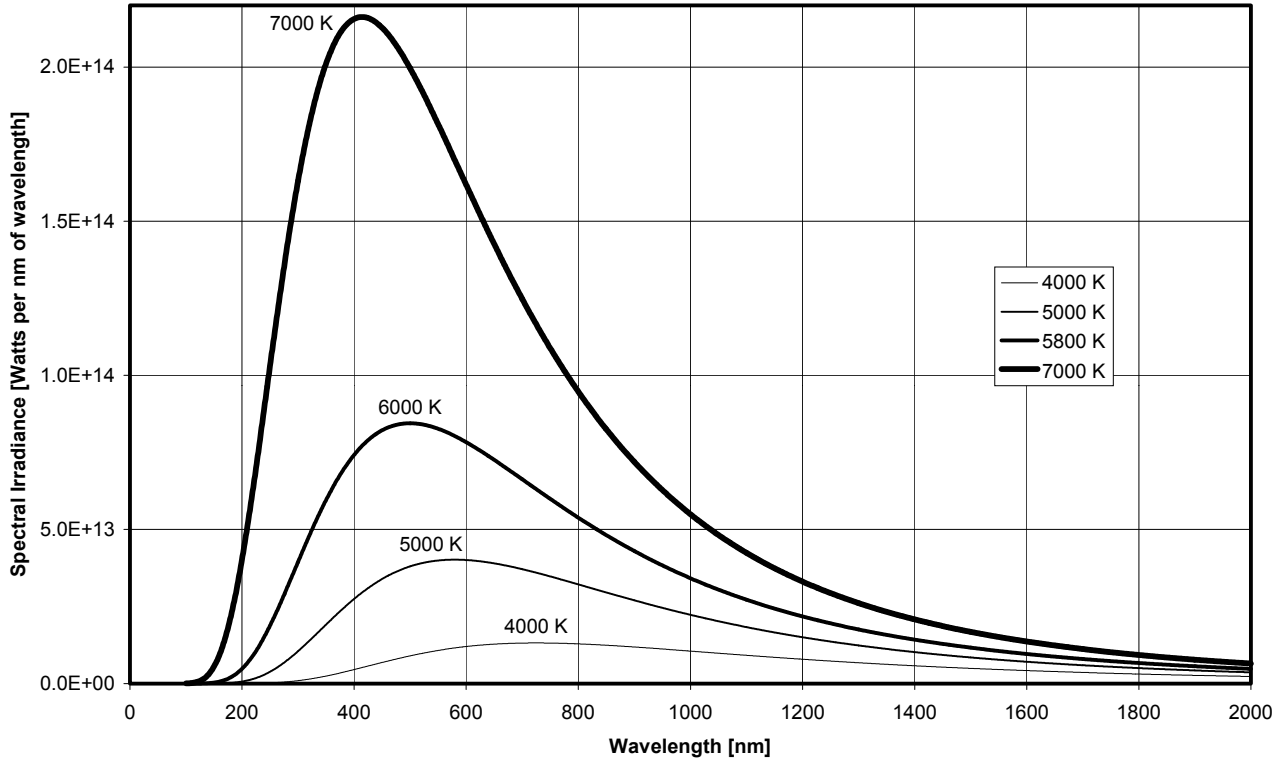
It is a bit tricky to estimate the reliability in your result though...that'll be most of what separates a good job from a great job on this assignment!

Please provide me with a copy of the computer file(s) you prepared for this problem by dumping it/them into the "Student Work:hand-in" folder inside the folder with your name on it in the chem370-0-s03 folder, on Fabio under "USR:COURSE:chem," or e-mailing it/them to me as an attachment. If your computer file is well-documented, that can be the whole of what you hand in. But otherwise please provide a written explanation of what you did and a written summary of your findings.

Don't wait to start on this until just before it is due, even if you are an expert at this sort of thing. Most people need some time to think about their results, time to digest their information, before they can complete something like this. If you get stuck, leave it and come back to it later. (That's great advice for research and mathematics in general, IMHO.)

Chem 370 / ENTS 369  
 Spring 2003  
 Carleton College

**Ideal Blackbody Radiation Spectra**  
 Spectral Irradiance per nm of Wavelength, per Square Meter of Blackbody Surface  
 as a Function of Blackbody Surface Temperature



Chem 370 / ENTS 369  
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**AM0 and AM1.5 Spectra**  
 Spectral irradiance per square meter of absorbing surface per nanometer of wavelength  
 Data Source: National Renewable Energy Laboratory, www.nrel.gov

