Name: _____ Course: _____ Date: _____

Exploring Planck's Law

This activity was designed to be completed using the following PhET simulation:
http://phet.colorado.edu/en/simulation/blackbody-spectrum

The simulation allows you to select a temperature and uses Planck's Law to plot the blackbody curve (emission spectrum) associated with that temperature as a function of the wavelength of the electromagnetic radiation. Try changing the temperature (by either dragging the knob or typing a number into the box) and observe how the emission spectrum changes.

Note: you may need to rescale the axes, using the magnifying glass icons to zoom in and/or out, to be able to read the plot at certain temperatures.

Once you have established some familiarity with the simulation…

COMPARING SPECTRA FROM DIFFERENT OBJECTS:

The cartoon thermometer on the right indicates the approximate temperature of the Sun, a light bulb, an oven, and the earth. Use the simulation to answer the following questions.

1. How are the spectra produced by the light bulb and the oven **similar**? List as many ways as possible

2. How are the spectra **different**? List as many ways as possible.

3. Explain the relevance of the position of the rainbow relative to the spectra.

DETERMINING THE RELATIONSHIP BETWEEN TEMPERATURE AND PEAK WAVELENGTH:
You should have noticed that both the intensity and the distribution of the spectrum change drastically with changing temperature (i.e., it was necessary to zoom both axes in order to see the spectra). Use the simulation to determine the relationship between the wavelength of the maximum intensity (λ_{max}) and temperature (T). You may use the space below to construct tables and/or sketch plots.

Do you notice any patterns? What is the mathematical relationship between T and λ_{max}?

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The "Plate Model" of the Greenhouse Effect

The "Plate Model," a system that consists of three glass plates stacked on top of each other under a bright light bulb, can be useful for providing insight about the troposphere (the lowest portion of the Earth's atmosphere) in a laboratory setting. Specifically, the plates model the way the troposphere responds to incoming solar radiation and outgoing terrestrial radiation.

The "Greenhouse Effect" is a process by which outgoing terrestrial radiation is absorbed by atmospheric gases, such as carbon dioxide, methane, and water vapor, and is re-radiated in all directions. Since the troposphere is essentially transparent to incoming solar radiation, without an atmosphere, the average surface temperature of the earth would be too cold to support life as we know it.

The following questions were designed to help you relate the plate system to the Earth's atmosphere and apply what you have learned about blackbody radiation in order to build a conceptual understanding of the important elements of the greenhouse effect.

1. Explain how the Plate Model relates to Earth and its atmosphere (e.g., what does the lamp represent, what do the plates represent, what part of the model corresponds to the earth).

2. What is Wien's Law and why is it relevant to a discussion of the greenhouse effect? Use evidence from the lesson to support your claim (e.g., absorption and emission spectra).

3. What properties of the "Plate Model" make it analogous to the earth-atmosphere-sun system? Why?

4. How is the model useful? What are the limitations of the model?