**PhET simulation Blackbody Spectrum**

**Purpose**

To understand the Blackbody radiation graph.

**Materials**

A computer with access to the internet, a calculator, and a physics text

**Background**

Everything emits Electromagnetic (EM) radiation. The sun does, operating incandescent lights do. We do. (Stand near an athlete who has been working out for an hour. You can feel the EM radiation (heat) being given off by the athlete) Buildings do. (Stand near a brick building’s west wall just after sunset and you can feel the EM radiation being given off). Anything at a higher temperature than its surroundings, gives off EM radiation. The amount of power liberated in the form of EM radiation depends on the object’s temperature in Kelvin, and its size in m2. As you will find out, the wavelength of the EM radiation is related to temperature.

It has been found that the total power of the EM radiation being emitted by an object is proportional to T4 (the fourth power of the object’s temperature in Kelvin)!

This EM (heat) radiation, under investigation in this simulation, should not be confused with an object’s color due to reflection. An apple, at room temperature, appears red because it absorbs all the spectral colors of the white light illuminating it except for red. The heating coils in an operating toaster are red because they are at a high temperature. At room temperature they are grey.

A blackbody, when illuminated by white light absorbs all the ROYGBIV spectral colors. The same “black body” illuminated by an infrared source may not absorb all infrared wavelengths. The electromagnetic energy absorbed by a blackbody is radiated back out at different wavelengths.

**Procedure & questions**

10. The violet end of the visible spectrum starts at a wavelength of ? µm.

11. The visible spectrum ends with red at a wavelength of ? µm

12. Convert these wavelengths into meters.

13. The simulation show that 1 µm = 1000 nm. What name is given to nm?

14. What would you say is the color of the EM “blackbody” source shown at the top as a star burst?

 15. Are all three spectral colors - blue, green, red – needed to produce this color?

16. What is the temperature shown for this EM blackbody source?

 17. What would this temperature be in Celsius?

18. Would a sensor that responds only to infrared be able to detect this EM source?

19. Would a sensor that responds only to ultraviolet be able to detect this EM source?

20. Names are given to different regions of the EM spectrum. Three have already been used. List at least seven of them from longest to shortest wavelength.

21. What is the formula that relates frequency to wavelength for EM waves?

22. What is the frequency of red light?

23. The energy output of the EM source is spread over a wide band of wavelengths and varies in strength. At what wavelength is the source’s output intensity the greatest?

Lower the temperature of the source,

 24. Describe the change in color of the source.

1. Describe the change in shape of the graph.

26How does the wavelength of the maximum intensity change?

Raise the temperature of the source,

 27.Describe the change in color of the source.

28.Describe the change in shape of the graph.

29.How does the wavelength of the maximum intensity change?

30.At what temperature would an oven heating element just begin to glow red?

31.What does this simulation assume is the average temperature of the earth’s surface?

32. What would this be in Celsius?

1. We see the earth by reflected light, but why don’t we see the earth glowing except at a few spots where there is an active volcano?

 34.Which of our senses would let us detect the EM radiation being given off by the earth?

35. According to this simulation, what is the color of an operating incandescent light bulb?

 36. Which spectral primary color is needed the least to produce the light bulb color?

 37. Is an incandescent light bulb primarily a light source or a heat source?

 38. How does this simulation help answer the previous question?

39. The new incandescent krypton lights used in gyms have a decidedly blue tint. How are they different from the incandescent bulbs you use in your house?

40. Convert the graph’s intensity units into words.

41. With your best prose or by using data from the graph, convince your instructor that you know what these units mean.

42. The outside daytime temperature went from 100C to 200C one day this fall. The temperature did not double. Why?

43. If a temperature of 100C were to double, what would be the new temperature?

44. What additional questions do you have that this simulation could help answer?