Homework 08

Physics II

Due Friday, May 31, 2024

College of the Atlantic. Spring 2024

There are two parts to this assignment.

Part 1: WeBWorK. Do Homework 08 which you will find on your WeBWorK page.

Part 2: Not WeBWorK. Here are some non-WeBWorK problems this week.

- If you want, you can do these problems in pairs and hand in only one write-up.
- "Hand in" the problem on google classroom. You can take a picture of your work, or type up your work, or scan your work.

1. The temperature of the sun is around 5800 Kelvin.
   (a) Was is the frequency at which the intensity of the radiation from the sun is the largest?
   (b) How does this frequency compare to the visible spectrum? Why do you think this is the case?

2. Suppose the temperature of a woodstove increased from 350 to 450 Fahrenheit. By what factor does the total energy radiated by the woodstove increase. (Note: You will need to convert the temperatures to Kelvin. You do not need to use the value of σ nor do you need to know the surface area of the woodstove to answer this question.)

3. In this problem we'll use the Stefan's Law to estimate a value for the metabolic rate of humans. Assume that the surface area of a person is 2 m^2 and that the surface temperature of a person is 30 C. Why 30? Because clothes trap some body heat, so the average temperature of a person's clothes might be around 30.
   (a) At what rate is energy lost via radiation given the assumptions above. Your answer should have units of Watts.
   (b) You should have found a worryingly large number for your answer to the previous question. We are indeed losing energy at the rate you found, but we are also gaining energy from the radiation of the surroundings. Let's say that the ambient temperature is 20 C. In this case, how much radiatiative energy is being absorbed by an average human. (The formula for energy absorption is the same the for energy emission.)
   (c) Find the difference between your answers to the above two questions. This is an estimate of the human metabolic rate. It's the net rate at which energy is lost, so that's how much energy your body needs to generate from food so that it can maintain a constant body temperature.
   (d) Your answer to the previous question should be in units of Watts. Convert this answer to Joules per day, using the fact that one Watt is one Joule/s.
   (e) Then convert your answer to dietary calories per day. One dietary calorie is approximately 4184 Joules. You should get an answer that is roughly the number of calories in a daily human diet.