Exercise 7
Due Friday, October 14, 5:00 pm

1. Thermal radiation from your body.

(a) Human body temperature is approximately 37°C. What is this on the kelvin scale?

(b) Estimate, *very roughly*, the surface area of your body in square meters. That is, if you were making a close-fitting garment to cover your entire body, about how many square meters of fabric would you need? (Explain briefly how you obtained your estimate.)

(c) The Stefan radiation law states that the power given off from an object as thermal radiation is:

Power in watts $= (5.7 \times 10^{-8}) \cdot$ (surface area in sq.m) $\cdot$ (temperature in kelvin)^4.

Calculate the approximate power given off by your body as thermal radiation. (Depending on your area estimate, your answer should be approximately 700 to 1500 watts.)

(d) How much energy do you give off as thermal radiation in one day? Please express your answer in joules, and round it off appropriately. (Hint: First calculate the number of a seconds in a day. A watt is a joule per second.)

(e) Convert your answer from part (d) to "jelly donuts." (A jelly donut is one million joules.) Compare the result to the energy in the food you eat, which is probably 8 or 10 jelly donuts per day. You should find that you radiate much more energy than is supplied by the food you eat.

(f) Why don't you freeze to death as a result of all this energy loss? (Hint: Unlike a typical star, you are usually not naked, surrounded by empty space.)

2. **Types of spectra.** Shown below are graphs of the spectra of three different light sources. For each graph, describe what the spectrum would look like (e.g., continuous, bright lines, dark lines, ...), if you were viewing it through a diffraction grating. Then describe the type of light source that would produce such a spectrum, and give at least two specific examples of such sources.
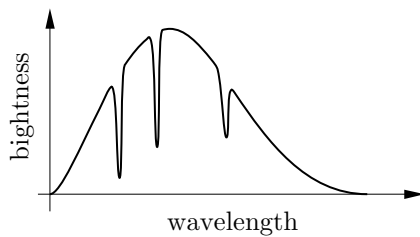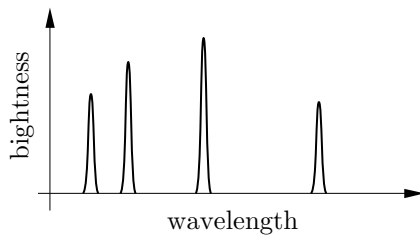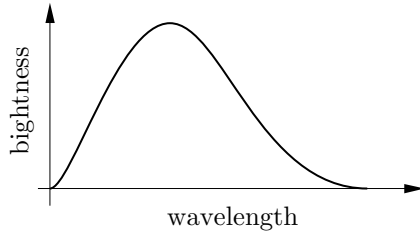
3. **Telescope light-gathering power.** Suppose that you wish to photograph a very faint galaxy. Using a one-meter-diameter telescope, your photograph requires an exposure of one hour. How long an exposure would be required if instead you use a two-meter-diameter telescope? Explain your reasoning. (Hint: Pretend your telescope is a bucket catching rain. If you make the bucket twice as wide, how long will it take to catch the same amount of rain?)