Homework #4
Due in class Wednesday, February 15

Answer parts 1 and 2 on a separate sheet of paper. You do NOT need to print this to hand it with your answers.

Part 1. Definitions

1. For each of the terms below, write two sentences. The first sentence should be a definition in your own words, and the second should be an explanation of how this concept is significant in Astronomy.

   a) Electromagnetic Spectrum
   b) Continuous/Emission/Absorption Spectrum
   c) Random Walk
   d) Wavelength
   e) Frequency

2. Using what you know about wavelength, frequency and energy, write one paragraph explaining whether you think UV light from the sun or microwaves from your microwave are more likely to cause damage to the cells in your body.

Part 2. Observing

(a) Using the film canister diffraction grating that you made in class, go out and observe at least two different "neon" signs. Choose them so that they appear to be different colors to your unaided eye (ex: one red, one purple). Sketch what you see through your diffraction grating carefully. As you did in the lab, pay particular attention to the colors, the number of lines and their relative brightnesses. Also, keep in mind that whenever you look at something through a diffraction grating, the shape of the object will carry through. Try to ignore the shape as much as possible and concentrate on the colors. On your sketch label where you were (restaurant, supermarket, etc.) and what color the sign appeared to your unaided eye.
Note: You may find also find a single "neon" sign that contains more than one color. If so, it already contains different elements and you only need to observe the one sign, but be careful in your observation. Remember that shapes carry over in spectra so use the shape of each part of the sign to tell the spectra of the elements apart.

(b) Go to the website http://astro.u-strasbg.fr/~koppen/discharge/ and study the 20 emission spectra shown there. Make your best guess as to which elements were in the neon signs you studied and justify your answer. If you're having trouble deciding between a couple of options, explain why. If you believe that the element(s) you observed is not among the 20 shown on this website (somewhat unlikely, but possible), justify that conclusion as well.

Extra Credit Option 1: If you slip the piece of grating film off of your diffraction grating and hold it in front of your camera lens, you should be able to take a picture of the spectrum of the neon light(s). If you do this successfully, you can either e-mail or print the picture and hand it in for extra credit.

Extra Credit Option 2: Many of the street lights in Tucson actually contain sodium vapor rather than a filament. How might you expect their spectra to be different? Develop a hypothesis and then go out and test it.

Part 3. Math Skill #3: Math Skill #3: Scientific Notation

A number in scientific notation has the form:

$$A \times 10^B$$

Where A is a number between 1 and 9.999999999 and can be either positive or negative, and B can be any whole number, positive or negative. If B is positive, it means that the number is very large. For example: 5×10^9 is 5 with 9 zeroes after it – 5,000,000,000, or 5 billion. If B is negative, on the other hand, it means that the number is very small. For example: 3×10^{-6} is a decimal point followed by 5 zeroes and then a 3 – .000003, or 3 millionths. In terms of easily turning the power in scientific notation into a number of zeroes, I like to think of this as 6 zeroes followed by a 3, with the decimal place between the first two zeroes. In other words, 0.000003.

As you turn a number in scientific notation with a positive exponent into a number in ordinary notation, you take away a power of ten every time you move the decimal place. In other words, 2×10^3 is the same thing as 20×10^2 is the same thing as 200×10^1 is the same thing as 2000. Note that at each step you simply took away one power of ten and folded it into the A part of your number. This works because a power of ten is nothing more than a bunch of tens multiplied together, and in math you can group multiplied numbers however you want. So 7×10^5 is $7\times10\times10\times10\times10\times10$, which I can group as $(7\times10\times10)\times(10\times10\times10)$, or $700\text{x}10^3$ or any other grouping that I can make and they will all be equivalent.

This process is very similar for a number in scientific notation with a negative exponent except that every negative power of ten represents a division by 10. So 3×10^{-4} is $3\div10\div10\div10\div10$. So every time you take away one of these powers of ten, you're folding one of those divisions into A. In other words, 9×10^{-3} is the same thing as 0.9×10^{-2} is the same thing as 0.09×10^{-1} is the same thing as 0.009.

The other way to think about this (and to verify it) is that a positive exponent translates to moving the decimal place to the right, and negative exponents mean moving it to the left. Every time you move the decimal point past an empty space, you fill in a zero as a placeholder. For example, to write out -6.12×10^4 you need to move the decimal place 4 places to the right. The first two times you move it over, there are already numbers there to hold the place, but for the last two moves you need to fill in a zero, so written out this is -61,200.

*Now for how this is actually useful. Writing a number in Scientific Notation has several advantages, which is why it is used so frequently in science. First, by writing a number in scientific notation, **the power of ten is built right in** so you can easily get a sense for how big or small the number is by using your powers of ten skills.*

Secondly, you will find that in many cases, especially dealing with very large or very small numbers, it is much easier to work with numbers in scientific notation than to *deal with their written out versions. It's easier to tell how big they are at a glance and easier on your hand to write them.*

Lastly, by writing a number in scientific notation, the number of significant digits is built right into your answer, which tells you how precisely you measured something. There are a number of complicated "rules" for significant digits, but they are made much simpler by scientific notation because ***if you bother to write it in scientific notation, then it is significant****. We will go over in more detail what "significant" means in the next math skill activity, but consider this statement in the back of your mind as you complete these exercises.*

Exercise 1: Rewrite the following numbers in scientific notation

10,000 =

100,000,000 =

0.00153 =

42,386 =

-0.00004 =

900 =

0.023 =

-8,599 =

Exercise 2: Write the following numbers in scientific notation out in normal notation

1×10^{6} =

$6.45\text{x}10^{-4}$ =

$3.14159\text{x}10^{16}$ =

$-4.238\text{X}10^{5}$ =

$2.001\text{x}10^{-5}$ =

$-9.2\text{x}10^{-10}$ =

Exercise 3: "Fix" the following numbers by putting them into proper scientific notation. Remember that your answer will be mathematically equivalent to the number given, but in many cases easier to look at. If you have trouble, refer to the explanations on the first sheet of this Math Skill activity, or come see me at office hours.

$30 \times 10^{2} =$

$1600 \times 10^{3} =$

$-125 x 10^{4} =$

$0.002 x 10^{-2} =$

$-0.00345 x 10^{-5} =$

$0.02 x 10^{4} =$

$250 \text{ x } 10^{-5} =$