Chemistry 4114, Chapter 5 homework

5.1

Frequency dependent – flicker noise and Environmental noise

Frequency independent – Thermal noise, Shot noise

5.5

a. A high pass filter allows high frequencies to pass and filters out the low frequencies. Flicker noise has a 1/(frequency) dependence, so it is most pervasive at low frequencies. The high pass filter will take care of it. Environmental noise occurs at 60Hz intervals. Dependent upon what is considered high frequency, a high pass filter might also take care of some of the environmental noise.

b. A low-pass filter allows low frequencies to pass and filters out the high frequencies. Again, dependent on what frequency is considered high and low, a low pass might be used to eliminate the environmental noise.

White noise contributions (shot and thermal) are frequency independent. Nevertheless, high-pass and low-pass filters will eliminate some of the contribution from each of these sources of noise. Clearly, it won't eliminate all possible contributions from a frequency independent source, but it will filter out some of the noise.

5.7

a. Using the data, we can calculate the average and the standard deviation from this data set. We find that the average is: 1.003, and the standard deviation is 0.0028

The RSD (relative standard deviation, the standard deviation normalized to the mean) is: 0.00279

And the S/N is equal to the inverse of the RSD: 358

b. The S/N is proportional to the $\sqrt{n}$, where n is the number of observations that go into determining the average and standard deviation of the measurement.

Given this, we can say that:

$$\frac{358}{500} = \frac{\sqrt{9}}{\sqrt{n}}$$

and n = 18 measurements

5.8

a. Using the same procedure as above, the average is 1.435 and the standard deviation is 0.271. This gives a S/N for this measurement of 5.30

b. To improve the S/N to 10,

$$\frac{5.3}{10} = \frac{\sqrt{8}}{\sqrt{n}}$$

and n = 29 measurements