Physics 225

Homework Assignment 2

Due 22 January 2008

1 Fireworks

Suppose the explosion of a firework produces 12 Watts of sound power. You are listening to it in the open, where there are no reflections and no sound shadows. To make life a bit easier, ignore reflections from the ground.

At what distance does the explosion sound as loud as normal conversation (60 dB)? Assuming that there are other noises around, so you can only notice the explosion sound if it is louder than 20 dB, at what distance is it just perceptible (just over 20 dB in loudness)?

Now, for fun, go to `http://www.csgnetwork.com/atmossndabsorbcalc.html` where you can look up the extra attenuation due to propagation through air. (Use standard temperature 20° C and 50% humidity.) This extra attenuation means that the real loudness is

$$\text{True Loudness in dB} = \text{Loudness you compute} \; - \; \text{Dist. in km} \times \frac{\text{dB attenuation}}{\text{km}}$$

where you can look up (dB attenuation/km) using the website.

The attenuation depends strongly on the sound frequency. What are the real loudnesses at 1 km and at 10 km distance if the explosion produces 100 Hertz sound? If it produces 1000 Hertz sound?

Why do you think that thunder and firework explosions mostly sound low pitched, especially if they are far away?

2 Reverb time

Estimate the sound decay time τ, sound decay halflife $\tau_{1/2}$, and reverberation time $t_{\rm reverb}$ of your bedroom [or some other room you have access to which you think is interesting.]

To do this you will have to measure/estimate the volume of your bedroom and the areas of surfaces (bed, floor, etc) in the room. Then you need to look up or estimate the sound absorption coefficients of the various surfaces in your room. Write down all of your estimates as part of the homework! You can find some numbers at

`http://www.engineeringtoolbox.com/accoustic-sound-absorption-d_68.html`

or

`http://www.saecollege.de/reference_material/pages/Coefficient%20Chart.htm`

The absorption coefficients depend on the frequency of the sound. Choose some sensible frequency between 100 Hz and 2000 Hz and do the calculation for sounds at that frequency. (if you are not sure about something, like the area or absorption coefficient of your sofa, make a reasonable estimate for the area and make something up for the absorption coefficient based on some similar material. You have to do estimates in the real world!)