Name: _____

Other group members: _____

Tutorial #9

PHYS 1240: Sound and Music

Friday, August 2, 2019

Instructions: Work in groups of 3 or 4 to answer the following questions. Write your solutions on this copy of the tutorial—each person should have their own copy, but make sure you agree on everything as a group. When you're finished, keep this copy of your tutorial for reference—no need to turn it in (grades are based on participation, not accuracy).

1. A singer sings a steady tone. Assume she has a cylindrical vocal tract that is 0.15 m long. Where is the frequency of the second formant peaked? (*Hints:* What wind instrument is the best rough approximation for a vocal tract? Which harmonics are present in such a model?)

2. Suppose you are analyzing the acoustics of a 20 m $\times$ 40 m concert hall with a ceiling height of 10 m. The floor is hardwood "platform," the ceiling is made from acoustical plaster, and the walls are made from plywood sheet mounted on studs. There is a 2 m $\times$ 4 m opening on the back wall. Assume this opening is a perfect absorber.

   (a) Sketch a picture of the concert hall.

   (b) What is the total volume of the room?

(c) What are the areas of the floor, ceiling, opening, and combined walls, respectively? (Do not include the area of the opening as part of the back wall.)

(d) Estimate the reverberation time T_r of the above concert hall at 1 kHz.

TABLE 15.1 Approximate typical absorption coefficients of various surfaces. Individual examples may vary considerably from these values.

Surface Treatment	Absorptivity at Frequency 125	250	500	1000	2000	4000
Acoustic tile, rigidly mounted	.2	.4	.7	.8	.6	.4
Acoustic tile, suspended in frames	.5	.7	.6	.7	.7	.5
Acoustical plaster	.1	.2	.5	.6	.7	.7
Ordinary plaster, on lath	.2	.15	.1	.05	.04	.05
Gypsum wallboard, $\frac{1}{2}''$ on studs	.3	.1	.05	.04	.07	.1
Plywood sheet, $\frac{1}{4}''$ on studs	.6	.3	.1	.1	.1	.1
Concrete block, unpainted	.4	.4	.3	.3	.4	.3
Concrete block, painted	.1	.05	.06	.07	.1	.1
Concrete, poured	.01	.01	.02	.02	.02	.03
Brick	.03	.03	.03	.04	.05	.07
Vinyl tile, on concrete	.02	.03	.03	.03	.03	.02
Heavy carpet, on concrete	.02	.06	.15	.4	.6	.6
Heavy carpet, on felt backing	.1	.3	.4	.5	.6	.7
Platform floor, wooden	.4	.3	.2	.2	.15	.1
Ordinary window glass	.3	.2	.2	.1	.07	.04
Heavy plate glass	.2	.06	.04	.03	.02	.02
Draperies, medium velour	.07	.3	.5	.7	.7	.6
Upholstered seating, unoccupied	.2	.4	.6	.7	.6	.6
Upholstered seating, occupied	.4	.6	.8	.9	.9	.9
Wood/metal seating, unoccupied	.02	.03	.03	.06	.06	.05
Wooden pews, occupied	.4	.4	.7	.7	.8	.7

SOURCES: Backus (p. 172) and L. Doelle, *Environmental Acoustics* (McGraw-Hill, 1972), p. 227.