TT3010 - Audio technology and room acoustics.
Exercise 6 - Music scales.

September 13, 2021

All tasks are based on chapter 9 in Rossings "Science of Sound" **?**. It is recommended that the student will try to do every task, but tasks marked *Mandatory* are to be handed in for approval (online). Deadline is November 16 at 16:00.

Tasks

1. Verify by direct multiplication that a major third in equal temperament has the ratio of 1.26 and a minor third has the ratio of 1.19.

2. From your knowledge of equal temperament, show that if you invest money at an interest rate of 5.9 % compounded annually, your investment doubles in 12 years.

3. *Mandatory* An octave-band sound analyzer measures the sound level in 10 octave bands with center frequencies 31.5, 63, 125, 250, 500, 1000, 2000, 4000, 8000, 16 000 Hz. What are the closest notes on the musical scale?

4. *Mandatory* The sound used in a touch-tone telephone have the following frequencies: 697, 770, 850, 941, 1209, 1337 and 1477 Hz. What are the closest notes on the musical scale?

5. Verify by multiplication that a fifth plus a fourth equals an octave in any tuning, as does a major sixth plus a minor third.

6. Using the frequency ratios given in figure 9.5, verify that the intervals C : G, E : B, F : C, G : D and A : E are perfect fifths in the just diatonic scale. Determine the frequency ratios for the imperfect fifth D : A.

7. *Mandatory* Find the frequency ratio that corresponds to 25 (cent). What are the frequencies of the note A4 + 25 (cent)? What about A4 - 25 (cent)?

8. *Mandatory* Some tuning forks are designed to a scale which the C's have frequencies that are powers of 2 (128, 256, 512 Hz, etc.). How many cents

flat are they compared to the international standard frequencies given in table 9.22?

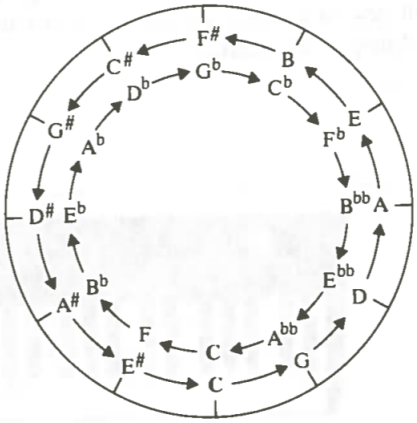

FIGURE 9.2
The circle of fifths. The outer circle visits all 12 notes on the chromatic scale by going up by fifths (or down by fourths). The inner circle goes down by fifths (or up by fourths).

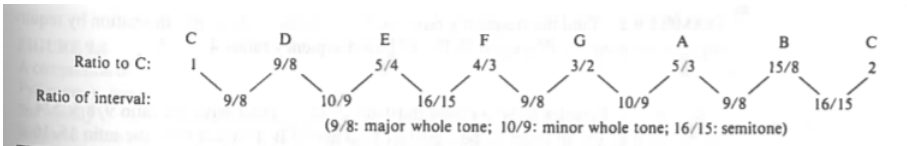

FIGURE 9.5 Frequency ratios of notes in the just diatonic scale. Numbers in the bottom row give intervals between two adjacent notes.

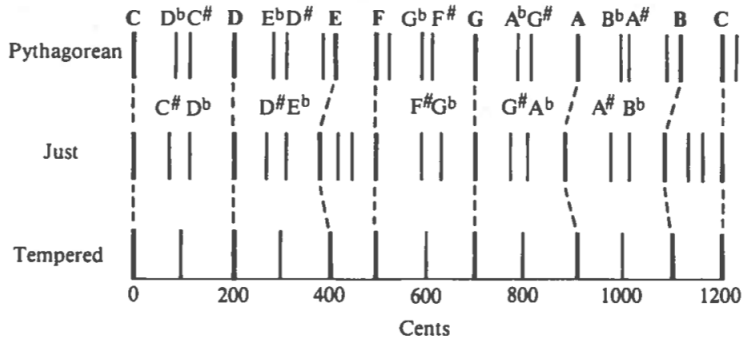

FIGURE 9.6
A comparison of Pythagorean, just, and equally tempered scales on a scale of cents (see Table 9.2).

TABLE 9.2 Frequencies of notes in tempered scale

C_0	16.352	C_3	130.81	C_6	1046.5
	17.324		138.59		1108.7
D_0	18.354	D_3	146.83	D_6	1174.7
	19.445		155.56		1244.5
E_0	20.602	E_3	164.81	E_6	1318.5
F_0	21.827	F_3	174.61	F_6	1396.9
	23.125		185.00		1480.0
G_0	24.500	G_3	196.00	G_6	1568.0
	25.957		207.65		1661.2
A_0	27.500	A_3	220.00	A_6	1760.0
	29.135		233.08		1864.7
B_0	30.868	B_3	246.94	B_6	1975.5
C_1	32.703	C_4	261.63	C_7	2093.0
	34.648		277.18		2217.5
D_1	36.708	D_4	293.66	D_7	2349.3
	38.891		311.13		2489.0
E_1	41.203	E_4	329.63	E_7	2637.0
F_1	43.654	F_4	349.23	F_7	2793.8
	46.249		369.99		2960.0
G_1	48.999	G_4	392.00	G_7	3136.0
	51.913		415.30		3322.4
A_1	55.000	A_4	440.00	A_7	3520.0
	58.270		466.16		3729.3
B_1	61.735	B_4	493.88	B_7	3951.1
C_2	65.406	C_5	523.25	C_8	4186.0
	69.296		554.37		4434.9
D_2	73.416	D_5	587.33	D_8	4698.6
	77.782		622.25		4978.0
E_2	82.407	E_5	659.26	E_8	5274.0
F_2	87.307	F_5	698.46	F_8	5587.7
	92.499		739.99		5919.9
G_2	97.999	G_5	783.99	G_8	6271.9
	103.83		830.61		6644.9
A_2	110.00	A_5	880.00	A_8	7040.0
	116.54		932.33		7458.6
B_2	123.47	B_5	987.77	B_8	7902.1