

Acoustic tasks week 3 – part 1

1. Consider a noise with the following 1/3 octave spectrum:

f (Hz)	100	125	157	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150	4000	5000
L_p (dB)	70	65	67	75	60	70	72	72	72	77	75	70	65	62	57	55	55	50

- a) Give its spectrum by octave band
- b) Determine the global noise pressure level

2. In order to measure the insulation of a wall to the airborne sound, we generate in one of the rooms a pink noise level $L_{p1} = 80$ dB/octave.

We measure the pressure level L_{p2} in the reception room with the help of a sonometer. The measure is done in the presence of background noise which level by octave band is L_{p0} .

f (Hz)	125	250	500	1000	2000	4000
L_{p1} (dB)	80	80	80	80	80	80
L_{p2} (dB)	60	55	50	42	36	30
L_{p0} (dB)	55	50	40	37	30	22

Determine the noise spectrum that is actually transmitted by the wall and the global level in dbA in the reception room.

3. a) Use Sabine's law to determine the reverberation time in the following rooms:

Dimensions (m)	Average absorption coefficient
Room 1: 8×8×2.7	$\alpha_1 = 0.04$
Room 2: 5×5×2.7	$\alpha_2 = 0.04$
Room 3: 15×12×3	$\alpha_3 = 0.04$

b) Instinctively, we associate large rooms with a long reverberation time. Is this correct?

Part 2

1. An auditorium has following dimensions:

Length $L = 40 \text{ m}$

Width $W = 20 \text{ m}$

Height $H = 5 \text{ m}$

The wall and floor have an acoustic absorption coefficient $\alpha = 0.25$.

a) The ceiling has an acoustic absorption coefficient α' .

We measure a reverberation time $T_R = 0.80 \text{ s}$ in the room.

The Sabine law is: $T_R = 0.16 V/A$, where V is the volume of the room, A is the equivalent absorption area of the room.

Calculate α' .

b) The equivalent absorption area of the room is $A = 800 \text{ m}^2$.

The room contains a source emitting uniformly in all the directions with a sound power $P=0.10\text{W}$.

In each point of the auditorium the global sound intensity I is the sum of two terms:

- Direct field intensity (originating directly from the source) $I_d = P/(4\pi r^2)$ at a distance r from the source.
- Intensity of the reverberated field (originating from the reflections on the walls) $I_r=4P/A$ in any point of the room.

At which distance r_l to the source do we have an equality $I_d = I_r$?

At this distance r_l , calculate the global sound intensity I_l and the corresponding sound intensity level.

Reminder: the sound intensity corresponding to the audition threshold is $I_0 = 10^{-12}\text{W/m}^2$.

2. Measure of the absorption coefficient α of a glass wool panel.

We would like to determine the absorption coefficients by 1/3 octave for a glass wool panel by using measured reverberation times for 2 different configurations:

Configuration 1: Empty reverberation room.

Configuration 2: Reverberation room with the walls covered by a surface S of glass wool.

Volume of the reverberation room: $V = 200 \text{ m}^3$.

Surface of the walls in the reverberation room: $S = 200 \text{ m}^2$.

Surface of the sample: $S_s = 12 \text{ m}^2$.

f (Hz)	100	125	160	200	250	315	400	500	630
T_0	13.7	10.9	6.5	6.2	6.3	6.1	6	6.5	7.1
T_1	12.3	8.6	5	4.6	4.3	3.5	3.0	2.6	2.5
f (Hz)	800	1000	1250	1600	2000	2500	3150	4000	5000
T_0	7.1	6.4	6.2	5.6	4.5	3.9	3.2	2.5	1.8
T_1	2.4	2.1	2.0	2.0	1.9	1.8	1.7	1.4	1.2

a) Determine the absorption coefficient of the glass wool panel.

b) Trace α as a function of the frequency f .

Answers

Part 1.

1. a)

f (Hz)	125	250	500	1000	2000	4000
L_p (dB)	72.6	76.3	76.8	79.6	67.2	58.6

b) $L_p = 83.14$ dB

2. $L_{pT} = 59.92$ dB(A)

3. a) Room 1: $T_{60} = 3.2$ s, Room 2: $T_{60} = 2.6$ s, Room 3: $T_{60} = 2.8$ s.

b) Size and shape of the room, together with the type of material covering the walls, determine the reverberation time.

Part 2.

1. a) $\alpha' = 0.56$

b) $r_l = 3.98 \approx 4$ m, $I_l = 10^{-3}$ W/m², $L_l = 90$ dB.

2. a)

f (Hz)	100	125	160	200	250	315	400	500	630
α_s	0.034	0.08	0.15	0.18	0.22	0.35	0.47	0.64	0.71
f (Hz)	800	1000	1250	1600	2000	2500	3150	4000	5000
α_s	0.76	0.88	0.93	0.89	0.85	0.84	0.79	0.9	0.83

b) $\alpha_s = 0.16 \cdot V/S \cdot (1/T_l - 1/T_0) + 0.16 \cdot V/ST_0$