

Task A.

1) Calculate:

- 1) The Room Index
- 2) The Utilisation Factor, from tables, explaining exactly how this value was arrived at.
- 3) The number of lamps required
- 4) A suitable layout (value of 5) for the lamp fittings.

2) Draw the plan layout on a scale drawing of the factory floor indicating your 'best fit' design for the luminaire installation.

1.1 The Room Index

Formula: $RI = (L \times W) / H_m(L + W)$

Known information: $L = 60m$

$$W = 24m$$

$$H_m = 8m - 1m = 7m$$

Known information input to formula:

$$RI = (60 \times 24) / 7(60 + 24)$$

$$RI = 2.45$$

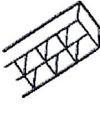
1.2 The Utilisation Factor

Known information: Area reflectance for ceiling = 0.3

Area reflectance for walls = 0.5

Using the Utilisation Factor Sheet for Fluorescent lamps in recessed louvre, this gives a Utilisation Factor of 0.46

UTILISATION FACTOR SHEET

Description of fitting	Typical outline LOR	Basic downward LOR%	Ceiling	0.7			Reflectances 0.5			0.3		
			Walls	0.5	0.3	0.1	0.5	0.3	0.1	0.5	0.3	0.1
			Room index									
Aluminium industrial reflector, aluminium or enamel high-bay reflector		70	0.6	0.39	0.36	0.33	0.39	0.36	0.33	0.39	0.35	0.33
			0.8	0.48	0.43	0.40	0.46	0.43	0.40	0.46	0.43	0.40
			1.0	0.52	0.48	0.45	0.52	0.48	0.45	0.52	0.48	0.45
			1.25	0.56	0.53	0.50	0.56	0.53	0.49	0.56	0.52	0.42
			1.5	0.60	0.57	0.54	0.59	0.57	0.53	0.59	0.57	0.53
			2.0	0.65	0.62	0.59	0.63	0.60	0.58	0.63	0.59	0.57
			2.5	0.67	0.64	0.62	0.65	0.62	0.61	0.65	0.62	0.60
			3.0	0.69	0.66	0.64	0.67	0.64	0.63	0.67	0.64	0.62
			4.0	0.71	0.68	0.67	0.69	0.67	0.65	0.69	0.66	0.64
			5.0	0.72	0.70	0.69	0.71	0.69	0.67	0.71	0.67	0.66
Near-spherical diffuser, open beneath		50	0.6	0.28	0.22	0.18	0.25	0.20	0.17	0.22	0.18	0.16
			0.8	0.39	0.30	0.26	0.33	0.28	0.23	0.27	0.25	0.22
			1.0	0.43	0.36	0.32	0.38	0.34	0.29	0.31	0.29	0.26
			1.25	0.48	0.41	0.37	0.42	0.38	0.33	0.34	0.32	0.29
			1.5	0.52	0.46	0.41	0.46	0.41	0.37	0.37	0.35	0.32
			2.0	0.58	0.52	0.47	0.50	0.48	0.43	0.42	0.39	0.36
			2.5	0.62	0.56	0.52	0.54	0.50	0.47	0.45	0.42	0.40
			3.0	0.65	0.60	0.56	0.57	0.53	0.50	0.48	0.45	0.43
			4.0	0.68	0.64	0.61	0.60	0.56	0.54	0.51	0.48	0.46
			5.0	0.71	0.60	0.65	0.62	0.59	0.57	0.53	0.50	0.48
Recessed louvre 0.23 trough with optically designed reflecting surfaces		50	0.6	0.28	0.22	0.18	0.23	0.20	0.17	0.23	0.20	0.17
			0.8	0.34	0.31	0.28	0.33	0.30	0.28	0.33	0.30	0.28
			1.0	0.37	0.36	0.32	0.37	0.34	0.32	0.37	0.34	0.32
			1.25	0.40	0.38	0.35	0.40	0.37	0.35	0.40	0.37	0.35
			1.5	0.43	0.41	0.38	0.42	0.40	0.38	0.42	0.39	0.38
			2.0	0.46	0.44	0.42	0.45	0.43	0.41	0.44	0.42	0.41
			2.5	0.48	0.46	0.44	0.47	0.45	0.43	0.46	0.44	0.43
			3.0	0.49	0.47	0.46	0.48	0.46	0.45	0.47	0.45	0.44
			4.0	0.50	0.49	0.48	0.49	0.48	0.47	0.48	0.47	0.46
			5.0	0.51	0.50	0.49	0.50	0.49	0.48	0.49	0.48	0.47

1.3 The number of lamps required.

$$\text{Formula: } N = \frac{E \times A}{F \times UF \times LLF}$$

Known information: $E =$ a required 200 Lux

$$A = 60\text{m} \times 24\text{m}$$

$F =$ a required 18,000 Lumen

$$UF = 0.46$$

$$LLF = 0.75$$

Known information input to formula:

$$N = \frac{200 \times (60 \times 24)}{18000 \times 0.46 \times 0.75}$$

$$N = 46.38$$

$N = 48$ lamps required.

1.4 A suitable layout

$$\text{Formula: } S_{\max} = 1.5 \times H_m$$

Known information: $H_m = 7\text{m}$

Known information input to formula:

$$S_{\max} = 1.5 \times 7$$

$$S_{\max} = 10.5\text{m}$$

Allowance of 10.5m max. between lamp fixtures.

Task 3.

- 1) Calculate the overall sound reduction index for the entire wall. Include the full arithmetic development of your answer.

Known information: Area of brick wall = 20m^2

Area of window = 4m^2

Brickwork sound reduction index = 50dB

Window sound reduction index = 10dB

$$\text{Formula: } T_0 = \frac{(T_1 \times A_1) + (T_2 \times A_2)}{A_1 + A_2}$$

Known information input to formula:

$$T_0 = \frac{(T_1 \times 16) + (T_2 \times 4)}{16 + 4}$$

$$20 - 4 = 16$$

16 = total brickwork area excluding window area.

Formula for missing information:

$$\text{SRI} = 10 \times (\log_{10}(1/T))$$

Known information: Brickwork SRI = 50dB

Window SRI = 10dB

Brickwork:

$$50 = 10 \times (\log_{10}(1/T_1))$$

$$\frac{50}{10} = \log_{10}(1/T_1)$$

$$5 = \log_{10}(1/T_1)$$

$$\frac{1}{T_1} = 10^5$$

$$T_1 = 10^{-5}$$

$T_1 = 0.000010$ transmission
efficiency of brickwork

Window:

$$10 = 10 \times (\log_{10}(1/T_2))$$

$$\frac{10}{10} = \log_{10}(1/T_2)$$

$$1 = \log_{10}(1/T_2)$$

$$\frac{1}{T_2} = 10^1$$

$$T_2 = 10^{-1}$$

$T_2 = 0.10$ transmission
efficiency of window area

New information input to original formula:

$$T_0 = \frac{(10^{-5} \times 16) + (10^{-1} \times 4)}{16 + 4}$$

$$T_0 = \frac{0.00016 + 0.4}{20}$$

$$T_0 = 0.020008 \text{ avg. transmission coefficient.}$$

Input to SRI formula:

$$SRI = 10 \times (\log_{10}(1/T))$$

$$SRI = 10 \times (\log_{10}(1/0.020008))$$

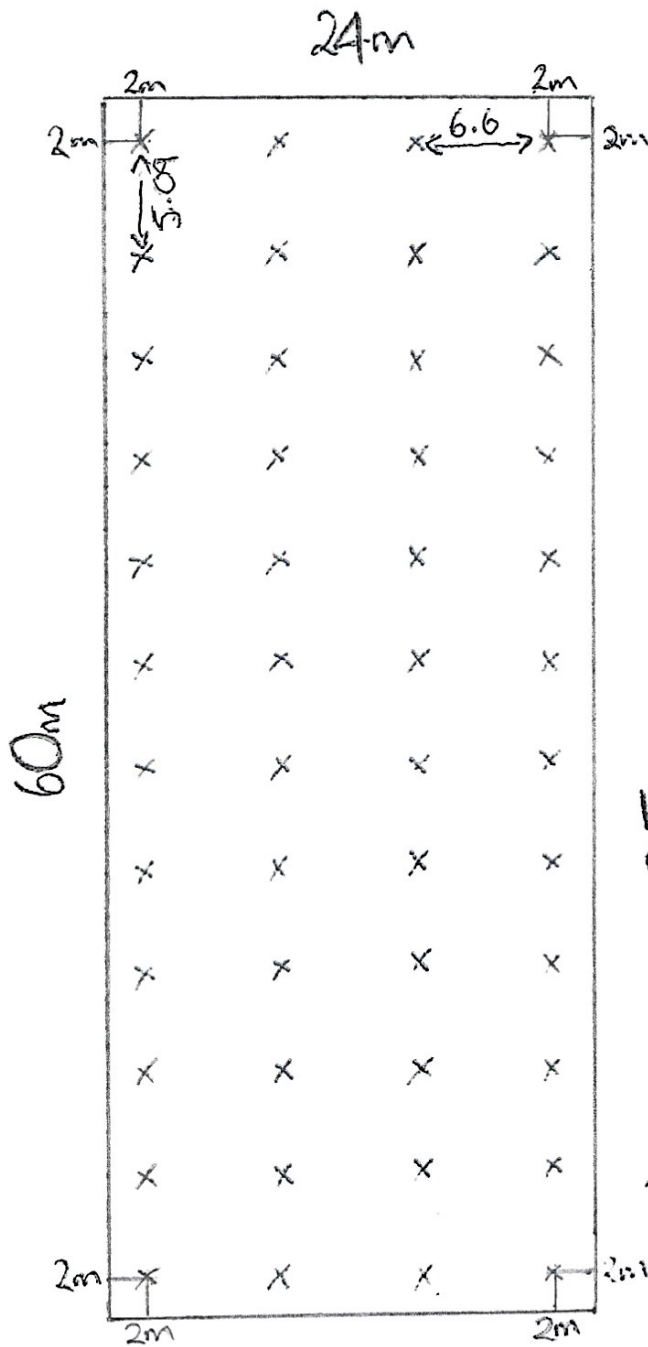
$$SRI = 10 \times (\log_{10}(49.980007))$$

$$SRI = 10 \times 1.69$$

$$SRI = 17\text{dB.}$$

Overall sound reduction index for the entire wall is 17dB.

Best Fit Design.



Room Measurements:

$$L = 60m$$

$$W = 24m$$

$$H = 8m$$

$$S_{max} = 10.5m$$

$$60 - 4 = 56m$$

$$\frac{56}{11} = 5.09$$

11 gaps between a row of 12 lamps.

$$24 - 4 = 20$$

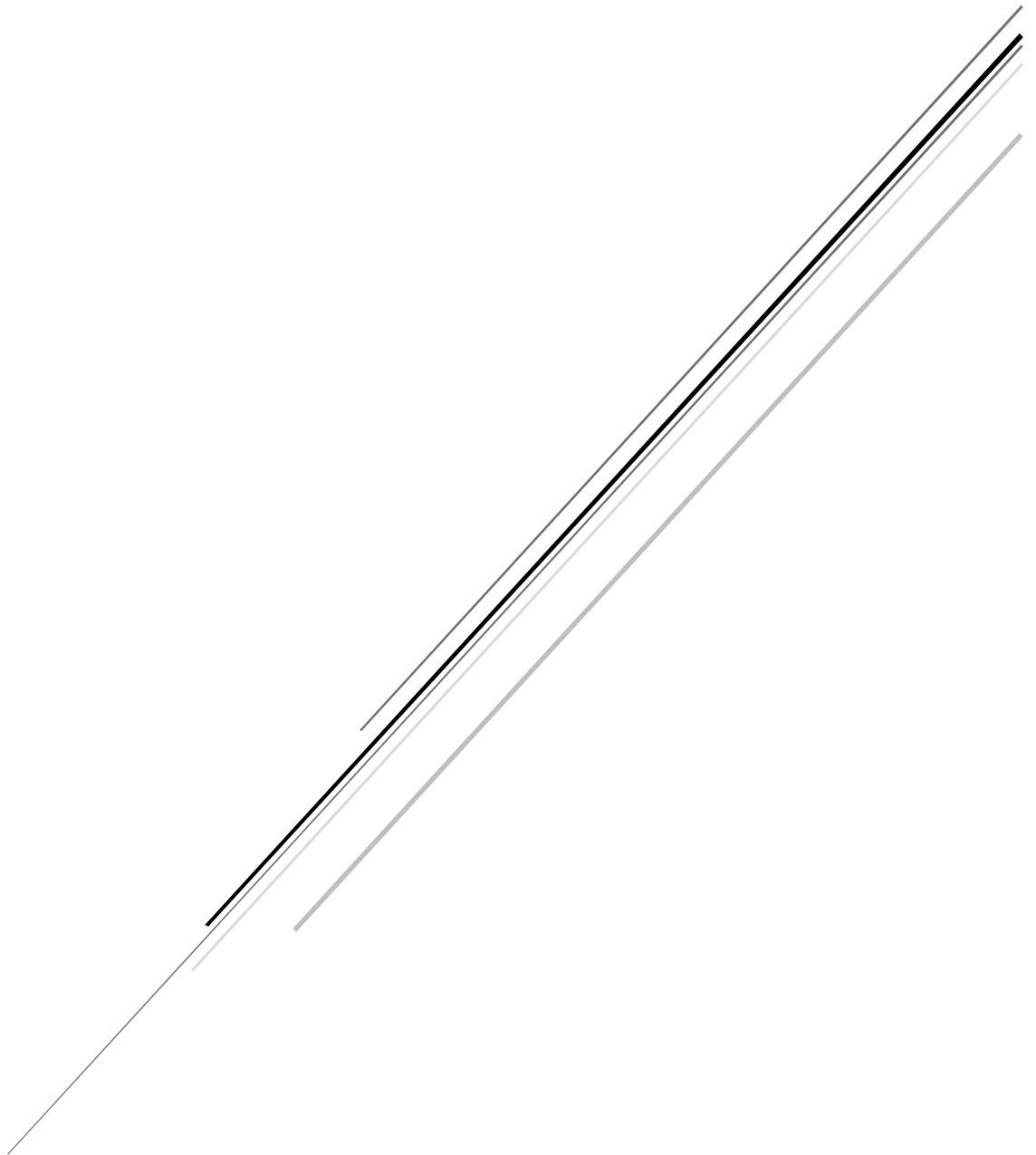
$$\frac{20}{3} = 6.6$$

3 gaps between 4 rows.

Best Fit would be 4 rows of 12 lamps.

FACTORS OF FREQUENCY AND WAVELENGTHS TO SOUNDS.

Discussing what implications the wavelength and factors of frequency have in internal sound management, partition walls construction techniques and the insulation material chosen.



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Introduction

Sounds are disturbances that travel in air taking the form of acoustic waves. Acoustic waves have characteristic frequencies and wavelengths depending on the nature of the source. Both frequency and wavelength determine the velocity of a sound ($V=F \times \lambda$) (Anon, 2021). The velocity of a sound remains constant within a fixed medium, this means that an increase in frequency will result in a decrease in wavelength and vice-versa. Frequency and wavelength are inversely proportional, this relationship inadvertently impacts almost all aspects of soundproofing. In the construction industry different techniques and materials can be used to help reflect, transmit or absorb sound waves.

Internal Sound Management

When considering sound management it is important to understand that if a sound wave encounters a barrier, it will partially reflect, absorb or transmit its energy in differing amounts. To optimise the acoustic performance of a structure or room it is important to identify which mode of energy transfer is required. For example, when designing a recording studio it would be preferable for the majority of energy to be absorbed with some partial reflection and very little transmission. Ideally the room should be 'acoustically treated' therefore absorbing ambient noises (EHRS, 2021). In order to achieve this it is best to select materials with low NRC values. Noise reduction coefficients (NRCs) describe how well sound energy is absorbed when making contact with a surface. Typical building materials can display varying NRC values as shown in the table below.

<i>Materials</i>	<i>S [m²]</i>	<i>Absorption coefficient as function of frequency [Hz]</i>				
		<i>250</i>	<i>500</i>	<i>1000</i>	<i>2000</i>	<i>4000</i>
Plaster (2 m)	205.31	0.05	0.06	0.08	0.04	0.06
Marble	50.78	0.05	0.05	0.05	0.05	0.05
Wood	36.24	0.20	0.15	0.10	0.15	0.10
Gypsum	593.11	0.15	0.10	0.05	0.05	0.05
Glass	80.17	0.06	0.04	0.03	0.02	0.02
Carpet*	484.15	0.10	0.30	0.50	0.65	0.70
Curtains*	83.65	0.15	0.35	0.40	0.50	0.50
Acoustic Plaster *	889.81	0.08	0.15	0.29	0.29	0.33

Figure 1: Absorption coefficient as function of frequency used in the numerical simulations. (*material used in the acoustic project of restoration) (Lenti & Ricciardi, 2010)

As well as the NRC value it is also important to understand what dominant frequencies a room may be subjected to. Lower frequency noises spread in all directions and can travel extreme distances due to their very long wavelengths. This makes them more difficult to muffle, unless the building material used is thicker than at least one wavelength of the incident sound. The speed of sound in air is approximately 340m/s therefore, a signal with a frequency of 100Hz has a corresponding wavelength of 3.4 metres (BBC, 2021). This makes it difficult to create barrier large enough to block low pitch noises. Modern methods of construction should balance the use of lightweight materials with general principles of soundproofing.

Partition Wall Construction Technique

It is equally as important to consider sound proofing when constructing a partition wall. It is currently stated within the Buildings Regulations Approved Document E, section E2 for England and Wales what the minim standards are for both protection from noise and noise transmission within buildings (GOV, 2015). Generally sound travels at different velocities through various substances, depending on their compressibility. Sound travels slower in more compressible materials, and faster in solid materials. solids offer less resistance than liquids or gasses due to their dense atomic structures (Bagley, 2014). When a sound wave encounters a different medium its velocity changes as a result. However the relationship between frequency and wavelength remains true. Partition walls typically consist of solid materials such as brick and block work, leading to potentially poor sound proofing (DBW, 2020). Lower frequency sounds can result in resonance in partition walls. Due to the length of the wavelength and its vibration against other properties of materials used within a partition wall additional protection is advised. This can be done by adding mass and insulation to the partition wall (Knauf Insulation, 2020). Low frequency sounds with larger wavelengths require approximately 1 inch of insulation per decibel. However, to suppress higher frequency sounds with shorter wavelengths every inch of insulation provides 4dB of attenuation. By using a combination of mediums with more compressibility you can reduce the transmission of low frequency sound waves (Soundproof Central, 2021).

The Insulation Material Choice

Material choice for insulation can be influenced by many aspects such as durability, moisture absorption as well as its sound proofing characteristics. Understanding which noise frequency and wavelengths the room is to insulate against will ultimately have implications on the chosen material. In a circumstance where the incident noise will mostly consist of lower frequency, therefore longer wavelengths, suggest that a material sufficient enough to suppress this noise will need to be chosen. For example, additional mass would be required from a material in order to subside any bass frequencies (Sound Proofing Company, 2021). Alternatively, higher frequency noise does not travel as well thus leading to materials that offer better absorption levels at a lesser mass. The incident sound that needs reducing or proofing will have a direct effect on the chosen material for insulation due to the different properties from both high and low pitches.

Conclusion

In summary, all aspects of building and construction can be somewhat influenced by the frequency and wavelength of sound. Additional consideration of these factors is necessary in order to accomplish the desired acoustic properties for a room. This can be achieved through various construction techniques and/or appropriate insulation materials/methods. By understanding the relationship between velocity, frequency, and wavelength it is possible to block or enhance specific pitches depending on the application. This is especially important when attempting to project specific sounds or muffle them completely. Ultimately, by understanding the impact of frequency and wavelength on sound it is possible to design buildings that ensure the correct comfort levels for its users, preventing public nuisance leading to a better overall build quality.

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