HABITAT TECHNOLOGY- MODULE 4

LIGHTING & ACOUSTICS OF INTERIOR SPACES

By
SANDRA MOHAN P
LECTURER IN CIVIL ENGINEERING
GPTC PALAKKAD

IMPORTANCE OF LIGHTING

- Lighting is an important aspect of interior design as it enhances the aesthetic appeal and creates the mood and ambiance of a living space. Lighting fixtures that illuminate a room creates a safe and comfortable environment besides adding style to the interior decor... Lighting can make or break the ambiance of a room.

NATURAL AND ARTIFICIAL LIGHTING

NATURAL LIGHTING

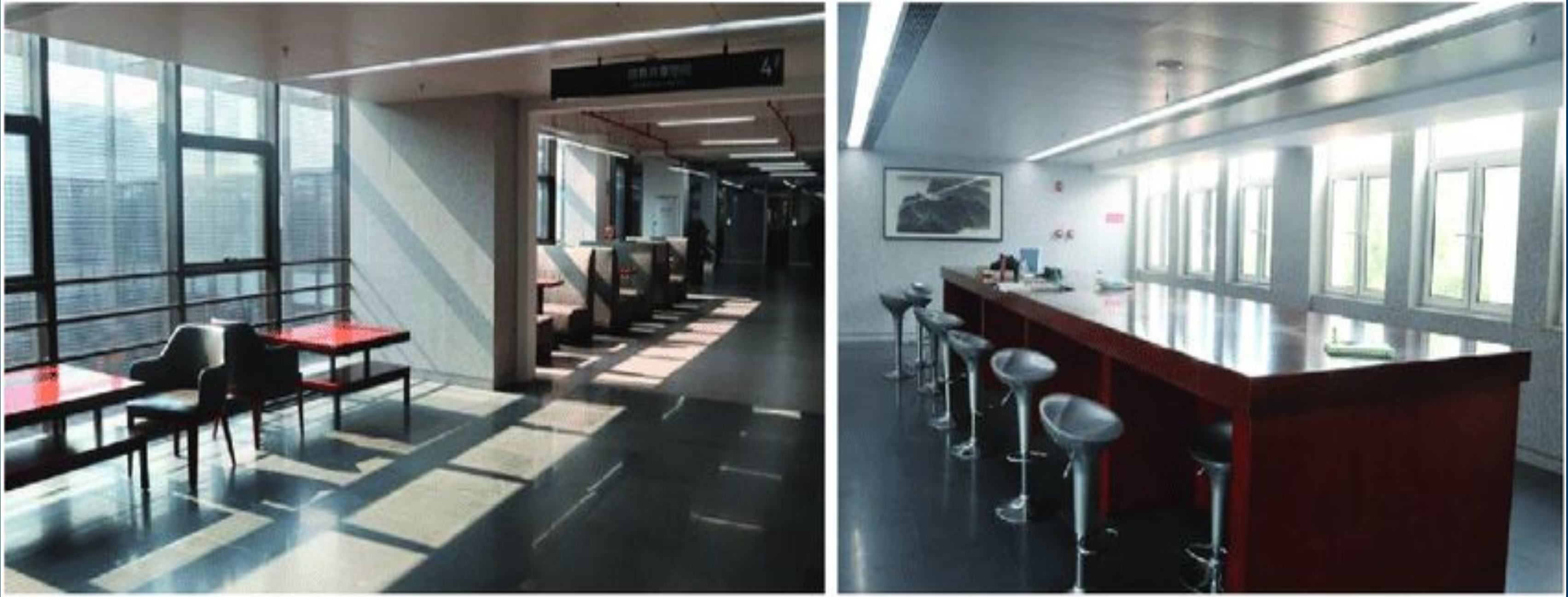
Defined as light provided by the sun, natural lighting can rejuvenate a home and capture the natural beauty of your surroundings. This type of light provides a touch of warmth and color to enhance the overall atmosphere. You can also obtain natural light from fireplaces and candles. These additional sources are more controllable and more reliable if you want a consistent way to use natural light in your home.

However, keep in mind that you often can’t control the intensity of natural light. So, many homeowners find that they need to light several candles to get the same effect as a single light bulb.

ARTIFICIAL LIGHTING

Even in homes with several windows, natural lighting can only extend so far into a room. This can be a problem in work areas where you need extra light to see what you’re doing. Rooms such as the kitchen, bathroom, and office all require us to focus on specific items and to have the clarity of sight to get the job done. Artificial lighting is the perfect solution in these areas, as you can install it wherever you need it to be.

With artificial lighting, you can also have control over how bright or dim the lighting is at any given time. This feature offers a variety of lighting options for you, depending on the situation and the atmosphere you want to create.



a : Natural lighting　　　b : Artificial lighting

ARTIFICIAL LIGHTING

Artificial light sources

- Incandescent
- Fluorescent
- Light-emitting diode (LED)

Types of artificial lighting

- Ambient lighting
- Task lighting
- Accent lighting

Artificial light sources

- Incandescent
- Fluorescent
- Light-emitting diode (LED)

FLUORESCENT

Compact fluorescent lights (CFLs) are available in various sizes and fittings and can be used in place of incandescent lamps without changing light fixtures. They are generally more energy efficient than incandescent bulbs. Some are dimmable and are compatible with other lighting controls. CFLs come in globe, spiral, floodlight and reflector variants.

INCANDESCENT

The traditional bulb-type lamp with a glowing filament, once commonly used in residential applications. They are generally considered to be the least energy-efficient choice of electric lamp but are inexpensive, turn on instantly and come in a range of sizes and shapes.

LIGHT EMITTING DIODES

LEDs are a rapidly developing lighting technology and one of the most energy-efficient lamps available. Compared to incandescent lamps, they can use around 75% less energy and can last 25 times longer although they can be more expensive. They are generally highly regarded for their comparable or better-quality light output compared to other lighting types.

TYPES OF ARTIFICIAL LIGHTING

- Ambient lighting
- Task lighting
- Accent lighting

AMBIENT LIGHTING

This is the general artificial lighting and overall illumination in a room. It can provide an even spread of light to give a comfortable level of brightness for most people to be able to see reasonably well and navigate safely around the room. Typically, it can be provided by a pendant fitting or ceiling downlights

TASK LIGHTING

This allows the completion of tasks such as reading, studying and way-finding. It is used where ambient light levels are insufficient for the task in hand. A reading lamp is an example, as are under-cabinet lights.

ACCENT TYPE

This type of lighting imparts drama and character and allows certain features regarded of interest to be highlighted. The idea is to draw the viewer’s attention to the item that is lit, whether a feature wall, an ornamental pool or an expensive vase.

PHOTOMETRIC QUANTITIES OF LIGHT

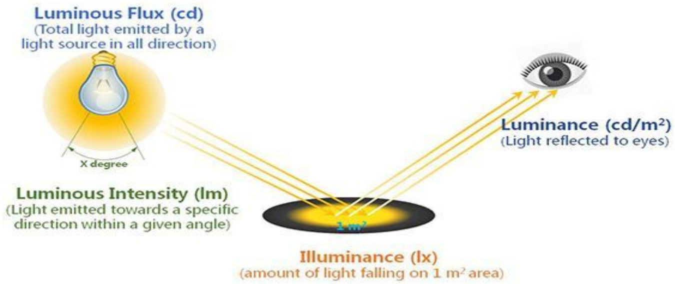
- LUMINOUS FLUX
- LUMINOUS INTENSITY
- LUMINANCE
- ILLUMINANCE AND LUMINOUS EMITTANCE
- LUMINOUS

1. **Luminous flux ϕ (lm)**

- Luminous flux describes the total radiance emitted by a light source as percieved by a human visual system
- Luminous flux also refered to as luminous power and is measured in lumens(lm)
- All other photometric quantities are related to the luminous flux

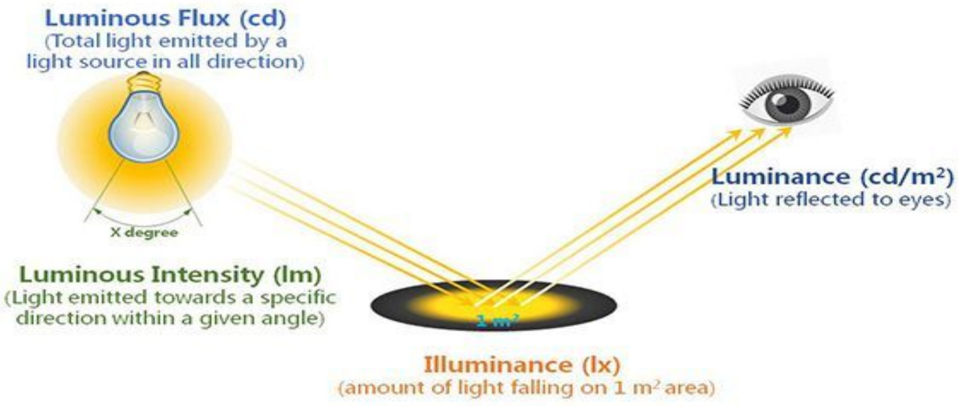
2. Luminous Intensity I (cd)

- Light sources do not emit light homogenously in all directions
- The luminance intensity describes the luminous flux emitted within a certain angle in a three dimensional space (solid angle **Ω** measured in steradians (sr))
- Unit Candela (cd) or lumens/steradian (lm/sr)



3. LUMINANCE L (cd/m2)

- The amount of luminous intensity that passes through (or emitted by) a certain area from a certain angle is described by luminance
- Taking the solid angle of a human eye as a measure of spatial distribution of light
- Luminance describes how bright an emitting or reflecting area would appear
- SI unit cd/m2
- Non SI unit “nit” 1 nit= 1 cd/m2



4. Illuminance and luminous emittance (lx)

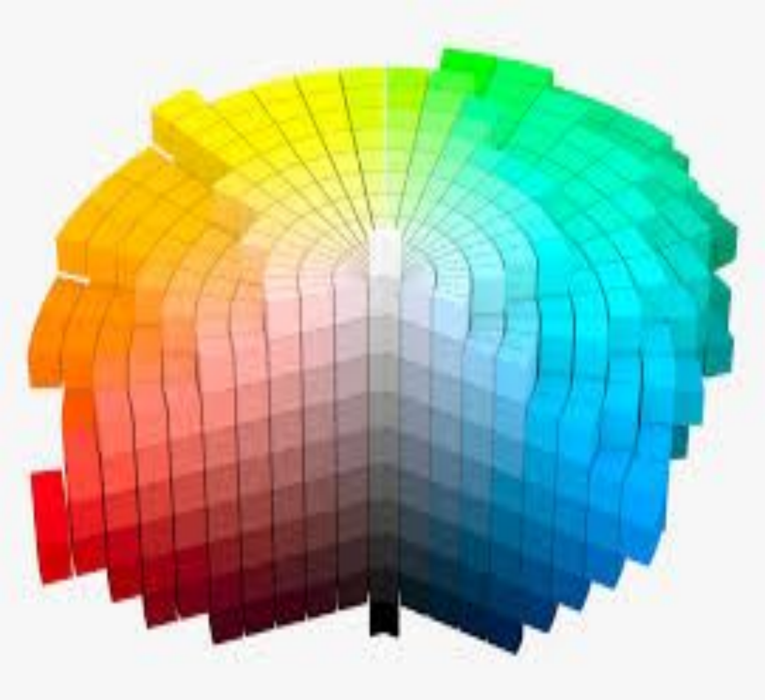
- Illuminance describes the quantity of a total light energy weighted by the eye’s sensitivity function incident on a certain area
- Luminous emittance is accordingly a measure of the total luminous power emitted from a surface with a certain area
- They both describe the total lumminous flux per unit area.
- It is measured in lumens per sq meter ou lux(lx)
- Sometimes it is also given in footcandles (fc), that is lumen per square foot (1 fc= 10.76 lux)

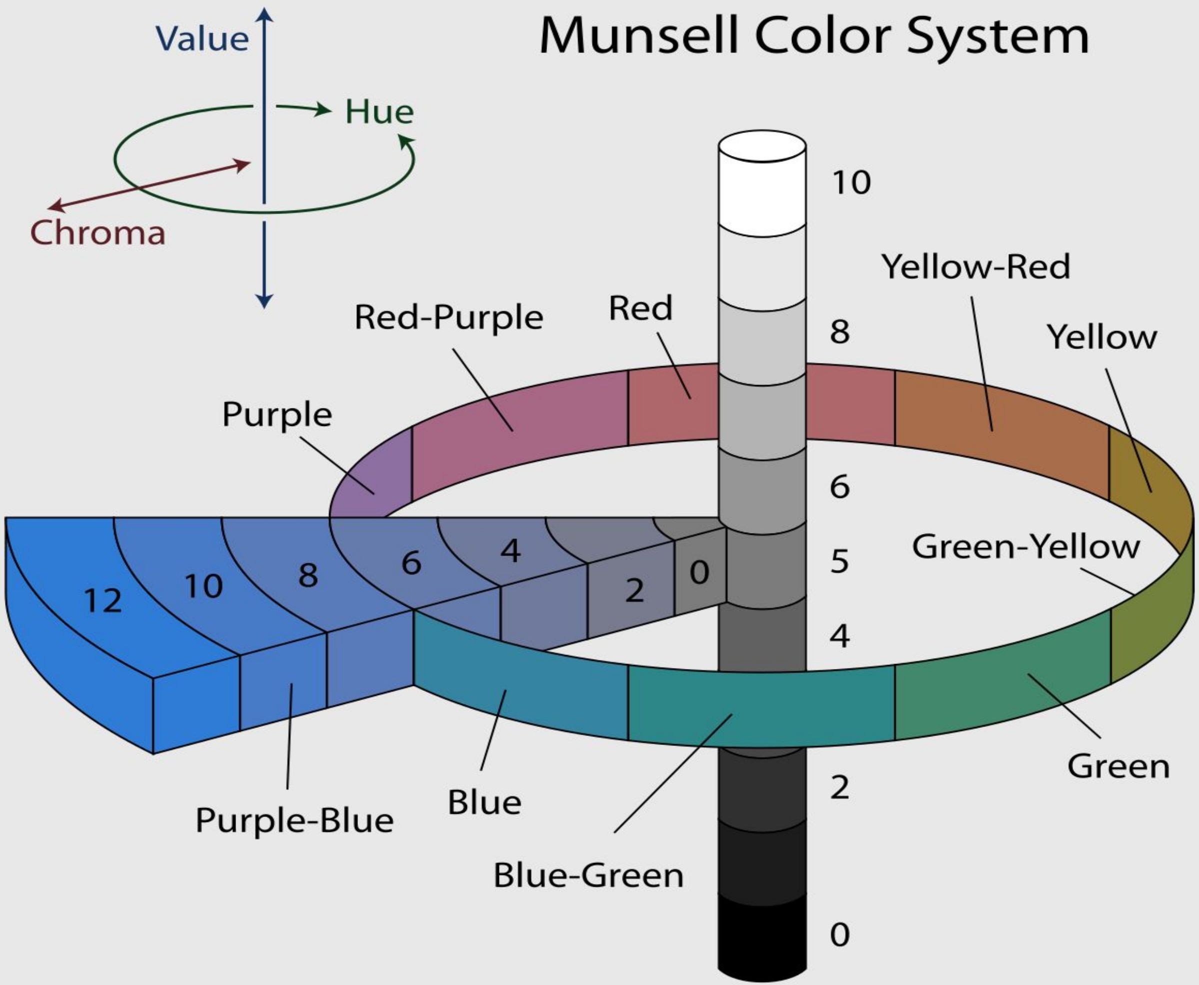
5. Luminous exposure H (lx.s)

- Exposure describes the accumulated luminous intensity applied to a certain area (eg camera sensor) within a certain time period
- In other words it is the illuminance per unit time
- The unit of exposure is therefore lux second (lx.s)

MUNSELL COLOR SYSTEM

- The munsell color system is system that specifies colors based on three color dimensions, hue, value, and chroma
- Professor Albert H Munsell created the system in the first decade of 20th century
- He created the system around a circle with ten segments arranging its colours at equal distances and selecting them in such a way that opposing pairs would result in an achromatic mixture
- The system consists of an irregular cylinder with the value axis running up and down through it, as does the axis of the earth
- The dark colors are at the bottom of the tree and light at the top measured from 1(dark) to 0(light)




Munsell Color System
Value
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Chroma
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5
4
2
0
Yellow-Red
Yellow
Red
Red-Purple
Purple
Green-Yellow
Green
Blue-Green
Blue
Purple-Blue
12
10
8
6
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2
0

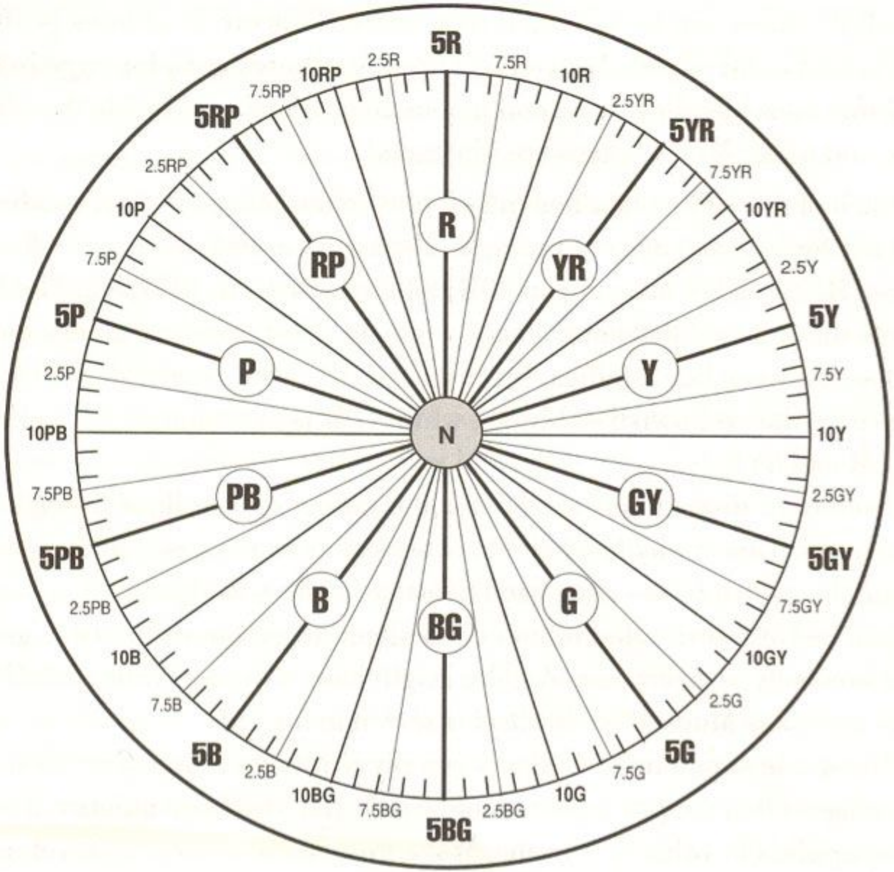
5R
7.5R
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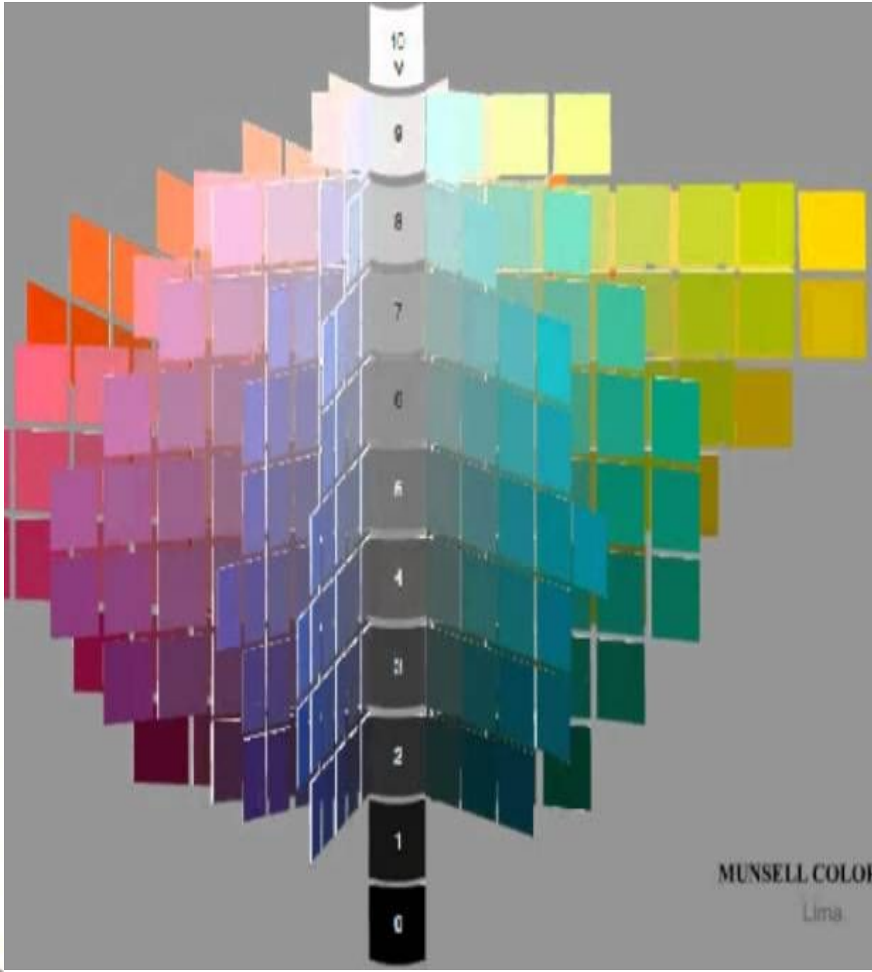
Fig. 1.2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MUNSELL COLO
Lima

Munsell Hue:

Hue is basically the exact colours thtat are Red, Green and Blue.

Munsell system has five principal hues- red(R), yellow(Y), green(G), blue(B) and purple(P) that are equally spaced around the circle of Munsell wheel and are arranged in clockwise manner when viewed from above. Between these five principal hues there lie the intermediate hues that are (YR, GY, BG, PB and RP). In total the system has 10 major hues.

Munsell Value:

Value refers to the lightness or darkness and it indicates the quality of light reflected. The value scale in Munsell system is from number 0 to 10 in which 0 represents the absolute black while 10 represents absolute white and the intermediate number shows the level from darkness to light.

Munsell Chroma:

The chroma value of Munsell represents the purity or the saturation of colour. It refers to the amount of visual difference from a grey of the same value, or in short term the Munsell chroma shows the distance from achromatic axis at which it is placed in the system.

ADVANTAGE

- Relatively simple system for comparing colors of objects by assigning them a set of numbers based on standard samples. Widely used in practical applications such as painting and textiles

DISADVANTAGE

- COMPLEMENTARY COLOURS ARE NOT ON OPPOSITE SIDES, SO THAT ONE CANNOT PREDICT THE RESULTS OF COLOR MIXING VERY WELL

ACOUSTICS OF INTERIOR SPACE

- Architectural acoustics is also known as room acoustics and building acoustics
- It is the science and engineering of achieving a good sound within a building and is a branch of acoustical engineering
- The first application of modern scientific methods to architectural acoustics was carried out by Wallace Sabine in the fog museum lecture room who then applied his new found knowledge to the design of symphony hall , Boston
- Architectural acoustics can be about achieving good speech intelligibility in a theatre, restaurant or railway station, enhancing the quality of music in a concert hall or recording studio, or suppressing noise to make offices and home more productive and pleasant places to work and live in
- Architectural acoustics design is usually done by acoustic consultants

SOUND AND NOISE

- Sound is a form of energy that is transmitted by pressure variations which the human ear can detect
- When one plays a musical instrument, say a guitar, the vibrating chords set air particles into vibration and generate pressure waves in the air. A person nearby may then hear the sound of the guitar when the pressure waves are perceived by the ear. Sound can also travel through other media, such as water or steel.
- Apart from musical instruments, sound can be produced by many other sources - man's vocal cord, a running engine, a vibrating loudspeaker diaphragm, an operating machine tool, and so on.
- Noise is unwanted sound. Usually the sound of a violin is referred to as music - is something pleasing. Depending on other factors, the sound may be perceived as noise.
- Noise perception is subjective. Factors such as the magnitude, characteristics, duration, and time of occurrence may affect one's subjective impression of the noise.

DIFFERENCES

- The magnitude of sound may make it undesirable if it disturbs people. Music at an acceptable volume might be pleasant, but raising the volume of the music too high causes it to become a nuisance
- The subjective desirability of sounds may also classify them as noises. Several people conversing in a room may classify all conversations other than their own as noise
- The setting of occurrence also occurrence also differentiate between sounds and noises. Loud sounds occurring in a socially acceptable setting such as a rock concert may be acceptable, whereas even whispering conversation is classified as noise in a library or religious ceremony
- Time of occurrence also differentiates between sound and noise. The sound of midday traffic may be acceptable, whereas this same magnitude is intolerable in the middle of night
- The duration of occurrence is the subjective time after which listening to a repetitive sound become annoying. Listening to a song a single time may be pleasant whereas listening to this song several times becomes an annoyance, leading to its classification as noise

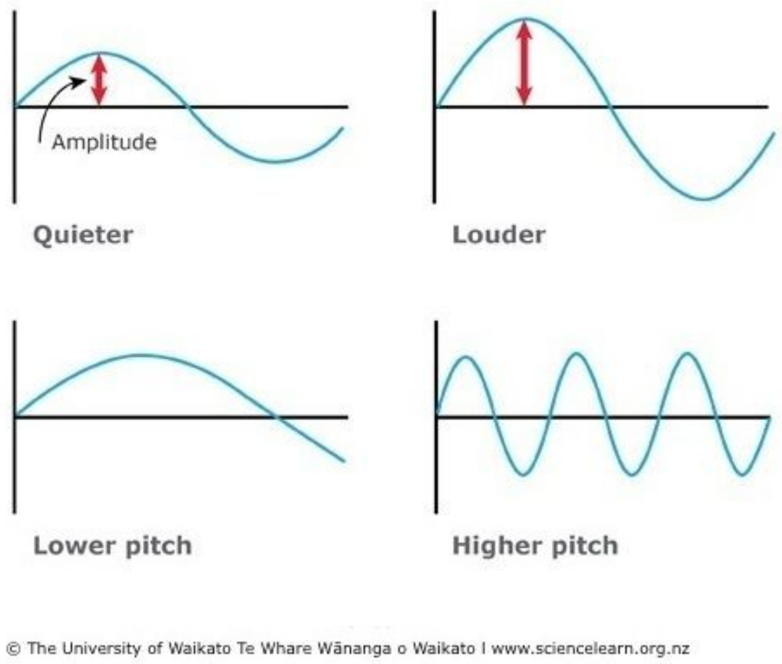
MEASUREMENT OF SOUND ENERGY

- Sound is a pressure wave caused when something vibrates, making particles bump into each other and then apart.
- The particles vibrate back and forth in the direction that the wave travels but do not get carried along with the wave
- When you clap your hands, you force air particles together and then apart . this effect ripples out and away from your hands as a small group of sound waves
- The particles close to your hands are pushed outwards and bump into neighbouring particles , and these then move and bump into more particles
- The effect is very much like droping a stone into a pool of water and causing a ripple pattern extending outwards from the original source
- Similar to water ripples , pressure waves move outwards from the sound source. These changes in particle spacing are also changes in pressure
- The pressure increases when particles are squeezed together and reduces when they move apart. It is these changes in pressure that can be detected by organs such as the human ear and are sensed as sound

MEASUREMENT OF SOUND

VOLUME

- Also called loudness
- Maximum pressure produced as particles are squeezed together as they aare made to vibrate
- This also related to the maximum distance particles are moved from their normal position as they vibrate , much like how tall the ripples are in the pool mentioned below
- When you show sound waves on a graph, the amplitude is the height of the waves from their middle position and reflects how loud the waves are.

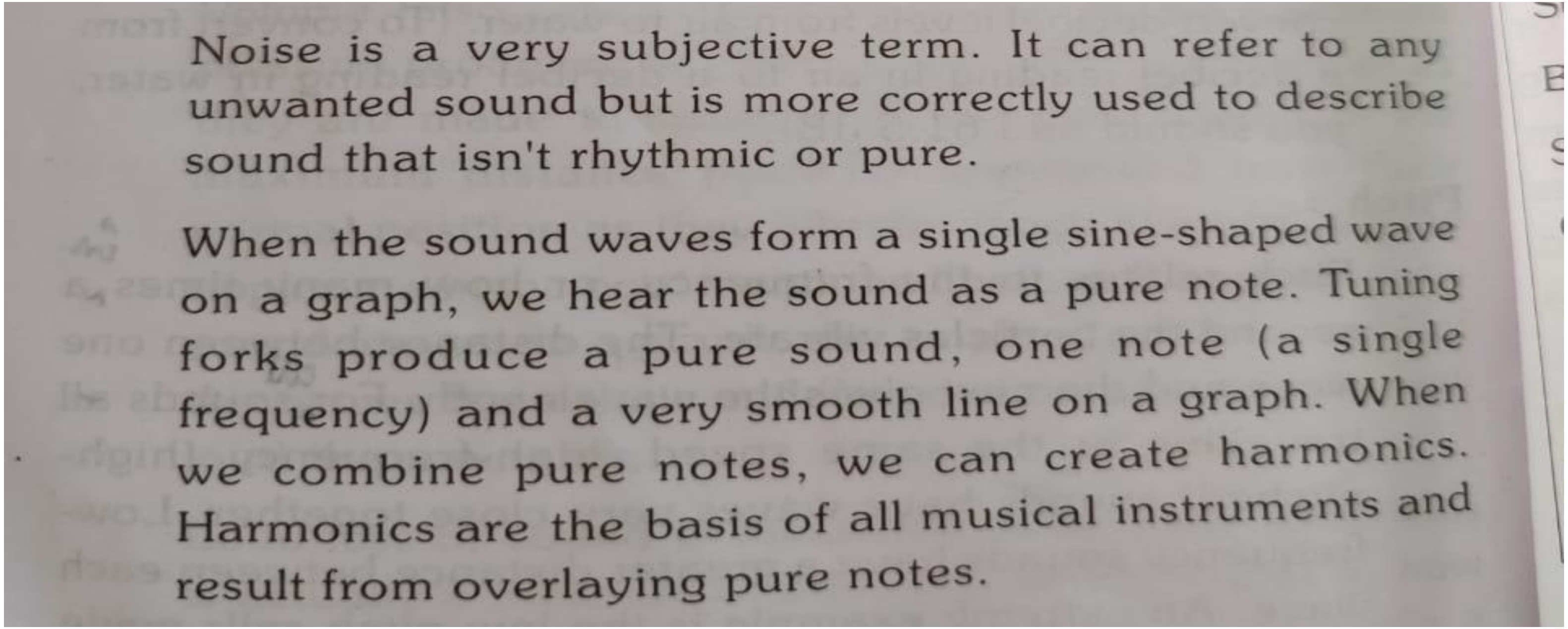


- Loudness of sound is measured in decibels(dB). This is actually a measure of intensity which relates to how much energy the pressure wave has. Decibels are relative measurement. They relate the intensity of a pressure wave to a normal or standard pressure
- For human ear--- 10dB to 61.5dB

PITCH

- Pitch relates to the frequency , or how many times in a second the particles vibrate
- The distance between one wave and the next gives the wavelength
- For all sounds travelling at the same speed , high frequency (high-pitched) sounds have very close together
- Low frequency sounds have a greater distance between each wave
- An example is the low pitch calls made by humpback whales which can have upto 100 metres between the pressure peaks of their sound waves
- Frequency is measured in hertz.
- For sound this means the number of pressure waves per second that would move past a fixed point
- It is also he same as the number of vibrations per second the particles are making as the number of vibrations per second as they transmit the sound
- A sound of 10 Hz means that 10 waves would pass a fixed point in 1 second

NOISE

- **Noise** is unwanted sound considered unpleasant, loud or disruptive to hearing.
- From a physics standpoint, noise is indistinguishable from sound, as both are vibrations through a medium, such as air or water. The difference arises when the brain receives and perceives a sound.
- 

Noise is a very subjective term. It can refer to any unwanted sound but is more correctly used to describe sound that isn't rhythmic or pure.

When the sound waves form a single sine-shaped wave on a graph, we hear the sound as a pure note. Tuning forks produce a pure sound, one note (a single frequency) and a very smooth line on a graph. When we combine pure notes, we can create harmonics. Harmonics are the basis of all musical instruments and result from overlaying pure notes.

tres

Noise is produced when the notes aren't pure. The trace on the graph is bumpy and random. Our ears detect this as a less pleasant sensation and often try to screen it out. In terms of listening under water, what we mainly hear is noise - a jumbled mess of sounds with no repeating pattern or clear pure notes.

4.8 THRESHOLD VALUES OF NOISE FOR COMFORT OF USERS :

Noise	Average decibels (dB)
Leaves rustling, soft music, whisper	30
Average home noise	40
Normal conversation, background music	60
Office noise, inside car at 60 mph	70
Vacuum cleaner, average radio	75
Heavy traffic, window air conditioner, noisy restaurant, power lawn mower	80-89 **(sounds above 85 dB are harmful)**
Subway, shouted conversation	90-95
Boom box, ATV, motorcycle	96-100
School dance	101-105
Chainsaw, leaf blower, snowmobile	106-115
Sports crowd, rock concert, loud symphony	120-129
Stock car races	130
Gun shot, siren at 100 feet	140

4.9 NOISE CONTROL METHODS :

The following points should be taken into consideration in the design and construction of auditoriums, cinema halls, lecture theaters and broadcasting studios.

The sound should be of adequate intensity so that it can be heard in each and every corner of the hall.

In lecture halls, the sound should be clear and distinct so as to avoid distortion.

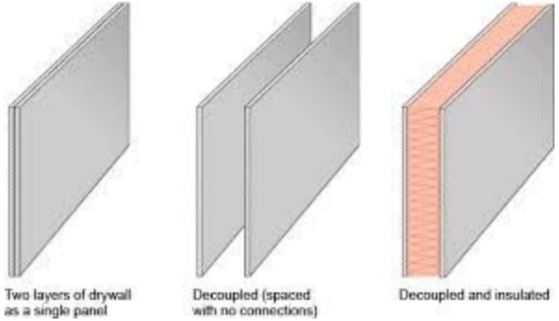
In halls for music and dance programs, the sound should reach the audience with the same frequency and intensity.

Disturbances from outside a hall should be reduced so that it does not interfere with the normal hearing of speech or music.

There are several categories of sound control for interiors: sound absorption, airborne sound transmission, and impact-sound transmission.

Sound Absorption :

Sound absorption is the capability of a surface, or building material, to absorb sound instead of reflecting it. Sound waves will continue to bounce around a room for a time after they are created if the majority of surfaces in a room is reflective. Surfaces that absorb sound better will not allow for reflections to bounce around as much, and will deaden the sound wave more quickly. Many common building materials, such as gypsum board, wood, concrete, brick and tile, are fairly reflective and do not absorb much sound. Softer materials, such as carpet, foam padding, and fiberglass insulation, are far better at absorbing sound.



The use of absorptive materials can be helpful in controlling sound. Fiberglass insulation is very absorptive and can be used where sound control is a concern. Thick carpet with padding is also very absorptive, and acoustical ceiling tiles are designed to absorb rather than reflect sound.

Even in cases where these options are not viable, absorptive materials can be added to finished rooms in other ways: furniture with thick cushioning is extremely absorptive, as are thick and heavy curtains and drapes. Items such as these can be added or arranged in ways that will allow for greater sound absorption. Acoustical baffles with absorptive materials can be purchased for use in areas where sound is a major concern, and most are designed to be unobtrusive and visually nondescript so as to allow for installation without drastically altering the aesthetics of a room.

Airborne Sound Transmission :

Airborne sound transmission in interiors deals with how well sound is controlled from room to room, and from the outdoors to indoors (or vice versa) through walls and ceilings. Sound transmission loss is the decrease in sound energy when it passes through a building element. Different materials provide different levels of transmission loss and, thus, different levels of diffusion of sound.

Dense, heavy materials increase the mass of floors and walls, allowing less sound to pass through. De-coupling can also be used to control sound, in this case. A break in framing or a resilient drywall connection breaks the path of vibration for the sound wave, causing it to halt.

This is the most effective method for controlling strong, low frequencies, which are the hardest to block. Blocking airborne sound from leaking through gaps and cracks by sealing them is also effective.

Impact-Sound Transmission :

After an impact noise is transmitted through a floor or ceiling assembly, the airborne sound that has made it through is the impact-sound transmission. The sound of someone stomping around on the floor above you is an impact sound transmitted through the ceiling to the room you are in. As with airborne sound transmission and sound absorption, the media of building materials used in construction come into play.

Wood joist floor-ceiling systems transmit a lot of impact sound. Adding fiberglass insulation will improve their capability of blocking impact sound, as will decoupling by using a wire-suspended drywall ceiling. Lightweight concrete flooring is generally good at reducing airborne sound transmission, but it does not do as well blocking impact sound. De-coupling is crucial to improving impact sound control in this instance. Resilient underlayments beneath floating floors can isolate the finished flooring from the concrete slab.

Specialty Construction Materials for Sound Control:

There are a number of specialty materials available for sound control. These are designed to provide strategic advantages over traditional materials, and are designed for use in situations where controlling sound or noise levels is of great concern. Many of these materials can be used during an initial build or installed at a later date, if the situation necessitates it. Some common examples are listed here.

- Mineral-fiber insulation is a special, denser type of insulation that can be used to improve a room's level of soundproofing. Its density is much higher compared to traditional fiberglass insulation, which makes it far more effective at stopping thetransmission of sound from one room to another. Mineral-fiber insulation also has a much higher burning point than standard fiberglass insulation, as well as a lower rate of moisture absorption.
- Sheets of limp mass, dense vinyl sound barrier are available for covering flat surfaces. The sheets are flame-retardant, and easy to install with plastic-cap nails or staples, or one can use trowel-applied, multi-purpose vinyl flooring adhesive. They are also available with an adhesive backing for even easier installation. These coverings are safe, inexpensive, and easy to work with. They can be cut with a standard utility knife or scissors.

cut with a standard utility knife or scissors.

- Floor de-couplers can be used to "float" a floor. De-coupling a floor is an effective way to minimize sound transmission. These floaters can be placed between the existing floor and a new level of flooring installed on top of them. They are inexpensive and will allow for the additional level of flooring to be removed at a later date, returning the floor to its original state.

- Resilient channels are pieces of metal made in a special shape that gypsum board or any type of drywall can be attached to in order to minimize sound transmission. One side of the resilient channel is attached to the stud, and the drywall is attached to the other side. Drywall that is isolated from framing in this manner will transmit far less sound than drywall mounted directly to studs.

Optimal control of noise in buildings can be achieved by understanding the basics of how sound moves through solid objects and air. Building materials will have the most impact on controlling sound in interiors, but strategic placement of absorptive materials in finished areas can also be very effective. Many of the materials listed above can be incorporated into a build when the situation calls for it, or installed at a later date, if it becomes necessary.