

## Chapter – 11: Sound

- Lots of sound – every day – sound of vehicles, toys, machines, people, birds, thunder, etc
- Anything you hear – sound
- Sensitive ears – hear the smallest sound
- Sound – continuous disturbance – produce sensations – human ear
- These disturbances – called vibrations – travel – wave-like motion

### Internal and External Sounds

- Lots of sounds – chewing, swallowing, breathing, etc – inside, outside body
- Hear – tummy rumble (make some sound) – listen to heartbeat – stethoscope
- Most imp. sound – communicate with each other
- Everyone – at least one language – voices – share thoughts, ideas, feelings
- Animals – their own sets of sounds – dogs – howl, bark, growl, whimper
- Humans – fill surroundings with sound – playing music, television, etc
- Almost everything – makes sound – noisy world
- Any sound – 3 points –
  - Origin – what makes the sound?
  - Propagation – how does sound travel?
  - Perception – how do we hear sound?

### Origin of Sound

- Anything – solid, liquid, gas – create sound – vibrating objects
- Vibrations – carry energy – travel through air – like waves
- Louder the sound – bigger the waves or vibrations

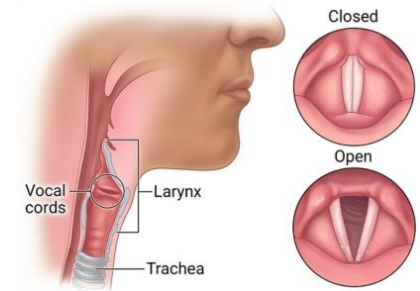
### Vibrations produce sound

- Vibration – ‘to and fro’ motion – from mean position
- This motion – oscillation – movement of object – one extreme position to another and back
- Mean position to one extreme – from there to another extreme – back to mean position – also one oscillation
- Time taken – one oscillation – time period (t) – unit – seconds (s)
- Number of oscillation per second – frequency (f) – unit – Hertz (Hz)
- Maximum displacement – mean position to either side – amplitude (A)
- All sounds – vibrations – one or another part
- Stretch string – violin, guitar, sitar – produce sound
- Some instruments – membrane (skin) – stretch – vibrate along air – produce sound
- Scratch inflated balloon – stretched rubber vibrates – produce sound
- Blow air – empty bottle – air inside – vibrates – produce sound

### Sound produced by humans

- Sound – produced by us – vibrations – vocal cords – present in larynx (voice box)

- Vocal cords – 2 bands of smooth muscle tissue
- Larynx – located in neck – top of the wind pipe
- Narrow passage – between cords – air pass
- Air pass through them – cords vibrate – produce sound
- Cords – attached muscles – make them – thick and loose
- Quality of sound – vary too much – when you hum – feel vibrations



### Sound produced by animals

- Some animals – dogs, cows, cats, etc – voice box – similar to humans
- Bees, housefly, etc – no voice box – vibrate wings – produce sound
- Frogs – inflate throat like balloon – produce sound
- Sound – falls on eardrums – they vibrate – brain interprets

### Propagation of Sound

- Sound waves – propagate (travel) – something vibrates
- Object – vibrates – disturbs air around it – air molecules – vibrate – gain some energy
- This energy – transferred to other molecules – close to them – starts a chain reaction
- This chain – called as sound wave
- Sound waves – travel through medium – source to listener
- Needs medium to travel – solid, gas, liquid – cannot travel in vacuum
- Speed of sound – depends on medium – fastest in solids – slowest in air
- Molecules in solids – closely packed – carry sound faster
- Telephone –
  - Mouthpiece of telephone – sound of voice – metal disc vibrates
  - Vibrations – changed to electrical signals – travel through wires
  - These signals – reach earpiece – another telephone – another disc vibrates
  - These vibrations – perceived (noticed) as sound by receiver

### Perception of Sound

- Sound – not visible – BUT – fill the surrounding – travel through air
- Ears, nerves, brain – help us to hear
- Night time – humming of insects – audible
- Recognise the voice of parents and friends – even if they are not in front
- Distinguish between different sounds – different sources
- Sounds – stored in memory – new sound received – brain compares it to memory – identify source
- Human ear – different parts – all have imp. roles –
  - Outer ear –
    - Outside part – pinna
    - Tightly stretched membrane – eardrum – separates outer ear from middle ear
    - Eardrum vibrates – sound waves reach it
  - Middle ear –
    - 3 bones – transmit vibrations to inner ear
  - Inner ear –

- Consists – cochlea – receive sound vibrations – send message to brain – auditory nerve
- Sound enter through pinna – travels through ear canal – reach the eardrum
- Eardrum vibrates – waves amplified by bones – travel to inner ear
- These waves – received at cochlea – transferred to brain – electrical signals – through auditory nerves

## Audible and Inaudible Sound

- Vibrations – produce sound – BUT – human ear – hear frequencies – 20 Hz to 20,000 Hz only
- This range – audible sound – audible frequency range
- Bats – capable – hearing other sounds – beyond the range
- Sounds – not audible to humans – inaudible sound
- Dogs – upto 50,000 Hz – monkeys, leopards – above 20,000 Hz – bats – upto 1,20,000 Hz
- Sound – frequency  $> 20,000$  Hz – ultrasonic – frequency  $< 20$  Hz - infrasonic

## Echo and Reverberation

- Sound waves – also reflect – like light waves
- Sound wave – falls on surface – some – absorbed – rest – reflected
- Amount of reflection – depend on surface
- Sometimes – distance between source and surface – adjusted in such a way – sound heard again after reflection – called echo
- Shout near a valley – your voice – heard multiple times
- Reflecting surface – not at particular distance – no echo
- Multiple reflections – various surfaces – auditorium, etc – sound heard – even after source stops – known as reverberations
- Reverberation – produce beautiful effects – orchestra
- BUT – sometimes – multiple sounds – disturbing – difficult to hear speaker clearly
- Auditorium features – false ceiling – heavy upholstery (chair covers) – absorb more sound – reduce reverberations
- Navigators – use reflection of sound – check depths OR position of submarines
- Ultrasonic waves – used for this – SONAR – Sound Navigation and Ranging



## Characteristics of Sound

- Loudness –
  - Sound – gets louder – when more energy enters our ear

- Source – vibrates with larger amplitude
- Guitar string – pull more strongly – amplitude increases
- Note – much higher – more energy
- Loudness – expressed in decibels (dB)
- Produced sound – travels in all directions – like a ripple in water
- Stand at a place – part of sound heard – BUT – sound beamed at you – hear whole sound
- People – make a cup with hands – behind ear – make a funnel – catch more energy
- Sometimes – people also use microphone
- Pitch –
  - Sharpness of sound – pitch
  - Sound waves – high frequency – high pitch – low frequency – low pitch
  - Musical sound – specific pitch – notes
  - Set of tuning forks – different frequencies – produce different frequencies
  - Tuning fork – 2 prongs (metal pieces) – vibrate when struck – move in and out together
  - Pitch of sound – decides sharpness – voice of child – much sharper – higher frequency
  - Factors affecting pitch –
    - Length –
      - Size of instruments – affects – pitch of notes
      - Instruments – guitar, violin, etc – longer string – lower pitch
        - Double bass – lower notes than violin
      - Instruments – flute, etc – cover, uncover holes – length of air column changes – notes changes
    - Thickness –
      - Guitar, violin – strings – different thickness
      - Thicker strings – heavier – do not vibrate quickly – lower pitch
    - Volume of air or liquid columns –
      - Greater volumes – lower notes
      - Example – flute
- Quality –
  - Quality (timbre) – another characteristics – distinguish between sounds – same pitch, same loudness
  - Sounds from different instruments – sitar, guitar, etc – differ in quality
  - Quality – depends on part of instrument – vibrates and produce sound
  - 2 people – identical vocal cords – voices – non-identical – different sound qualities
    - Reason – quality of sound – depend on shape of source – mouth cavity, tongue, teeth, etc

## Musical Instruments

- Work – making sound waves
- Shape, size, material – affects the sound
- Some instruments – sounds box – resonates – vibrates at same frequency as the original sound – sound gets fuller, richer
- Divided into following groups –
- **Stringed instruments** –
  - Instruments – violin, guitar, sitar, veena, harp, etc – stretched strings – vibrate – pluck them

- Piano – string vibrates – hit by hammers – controlled by keys
- More vibrations – louder sounds
- All instruments – different thickness, tension of strings, length of strings – different sounds
- **Wind instruments –**
  - Work – column of air – vibrates inside
  - Vibrations produced – different ways
  - Trumpet – player’s lips – vibrate – cup-shaped mouthpiece
  - Sound – amplified (made louder) – tube and flared (widened) end
  - Flute, nadaswaram – wind instruments
- **Percussion instruments –**
  - Work – beaten, scrapped, shaken
  - Drum – tight skin – beat with hand, stick, etc – produce vibrations
  - Vibrations – air inside drum vibrates – hollow shape amplifies sound
  - Other instruments – majira (cymbals), mud pots
  - These instruments – commonly used – different parts
  - Bell, jal tarang – examples
  - Jal tarang – different bowls – different amount of water – stuck with stick – musical sound produced
- **Electrical instruments –**
  - Electric guitar – small sound vibrations by strings – amplified by electronic amplifier
  - Sound – changed to electric signals – change back to sound after amplification

## Music and Noise

- Music –
  - Sound – regular pattern – made by instruments
- Noise –
  - Unwanted, irritating sound – clattering, banging, drills, badly played music – irregular patterns
- Most people – recognise music – BUT – music – different for everyone

## Minimizing Noise Pollution and its Hazards

- Unpleasant sound – noise – presence of noise – noise pollution
- High pitched noise – more annoying
- Noise pollution – damage ears and other hearing problems
- Common causes – flying aircraft, moving vehicles, loud music, machinery, etc
- Reduction methods –
  - Fitting silencers – vehicles
  - Sound-insulating (absorbing) materials – curtain, carpet, etc
  - Trees – between house and road
  - Ear protectors – minimize noise effects – factory workers, truck drivers, etc
  - Insulating noisy rooms – air gap between walls – sound does not travel