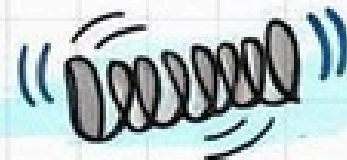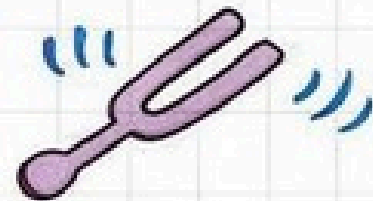# SOUND

Quick Revision Guide

1 Production of Sound

- Sound is produced by **vibration** of objects
- Sound is a form of **energy** that produces sensation of hearing
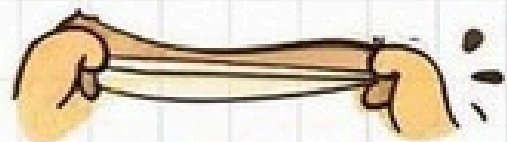- **Vibration** = rapid to-and-fro motion of an object
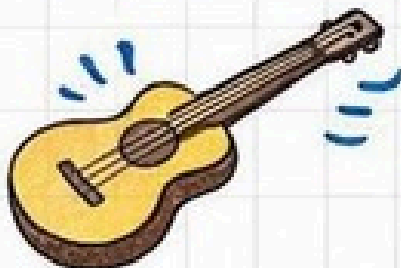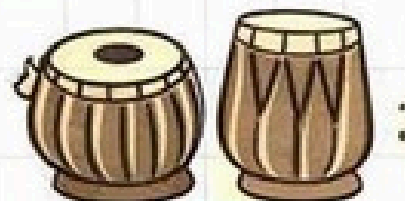
Examples:

- Vocal cords

  Ah

- Stretched rubber band

- Vocal cords

- Tuning fork

- Musical instruments

SOUND

Quick Revision Guide

2. PROPAGATION OF SOUND

Medium & Wave Nature

- Sound requires a medium (solid, liquid, or gas) to travel

- Sound waves are mechanical waves and longitudinal waves

- Particles oscillate parallel to direction of wave propagation

- Particles don't travel; only disturbance travels through the medium

- -

Compressions & Rarefactions

Compression (C) ←——————→ Rarefaction (R)

Region of high pressure/ density

Region of low pressure/ density
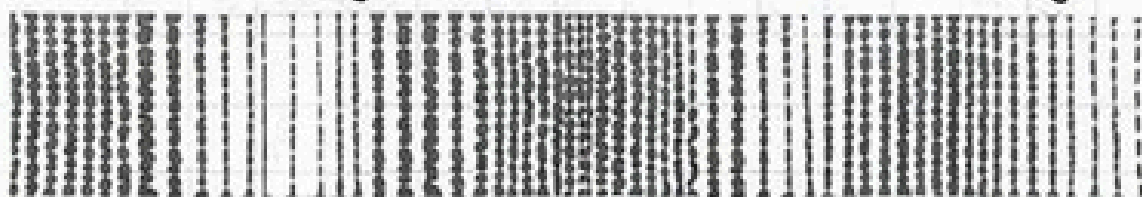
Direction of Wave ——————→ Direction of Wave

- Sound propagates as series of compressions and rarefactions

SOUND

Quick Revision Guide

3. CHARACTERISTICS OF SOUND WAVES

Key Parameters

- **Wavelength (λ)**
  - Distance between two consecutive compressions or rarefactions: unit = m

- **Frequency (ν)**
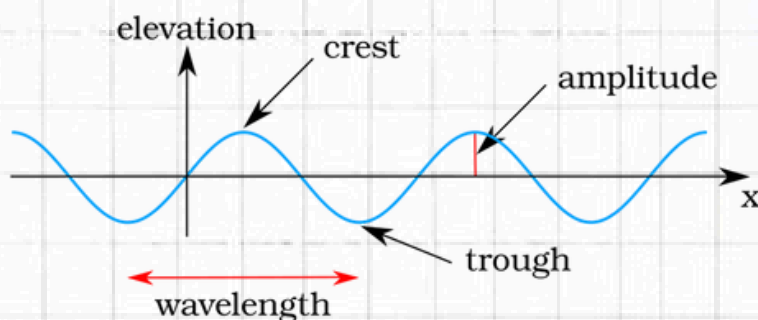 - Number of oscillations per unit time

- **Time Period (T)**
  - Time for one complete oscillation

- **Amplitude (A)**
  - Maximum displacement from mean position
  - unit: density or pressure

Key Formulas

$$v = \frac{1}{T} \quad \text{or} \quad v = \lambda v$$

where v = speed of sound, λ = wavelength, v = frequency
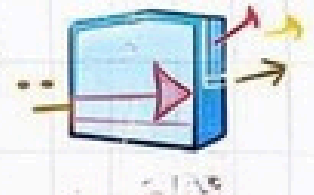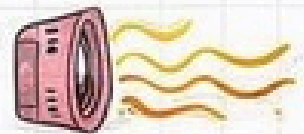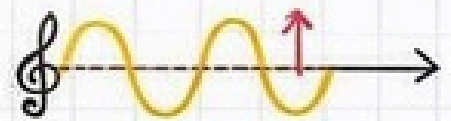
PhysicsCatalyst

SOUND

Quick Revision Guide

4. SOUND PROPERTIES & SPEED OF SOUND

Sound Properties

- **Pitch** : Determined by frequency
  Higher frequency →

- **Loudness:** Determined by amplitude →
  Larger amplitude →

- **Quality/Timbre** : Distinguishes sounds of same pitch and loudness

- **Intensity:** Sound energy pass per second through unit area

Speed of Sound

- Speed depends on nature of medium and temperature
- Solid decreases: Solid > Liquid > Gas
- Speed increases with temperature increase

Important Values (at 25°C)

Air : 346 m/s   Water (distilled): 1498 m/s
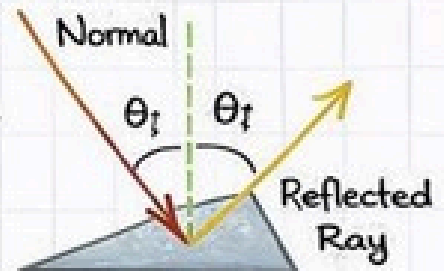
Steel: 5960 m/s   = 5960 m/s

SOUND

Quick Revision Guide

PhysicsCatalyst

5. REFLECTION OF SOUND

Laws of Reflection

- Angle of incidence = Angle of reflection
- Incident ray, reflected ray, and normal lie in same plane.

- **Echo:** Reflected sound heard distinctly after original sound
  - Minimum time gap for distinct echo: 0.1 s
 - Minimum distance for echo (at 344 m/s): 17.2 m

$$Distance = v \times \frac{t}{2}$$

Reverberation

- Persistence of sound heard distinctly after original sound
- Reduced using sound-absorbent materials (fibreboard, rough plaster, draperies)
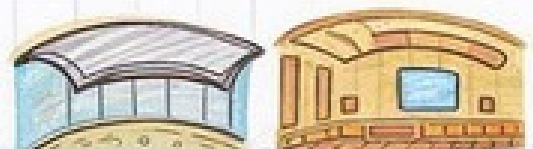
Applications of Multiple Reflection

- Megaphones, horns, trumpets (direct sound in specific direction
- Stethoscope (multiple reflections guide sound to ears
- Soundboards (reflect sound across auditorium)
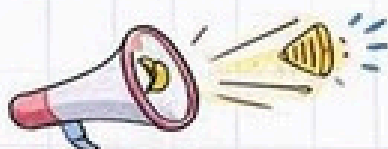
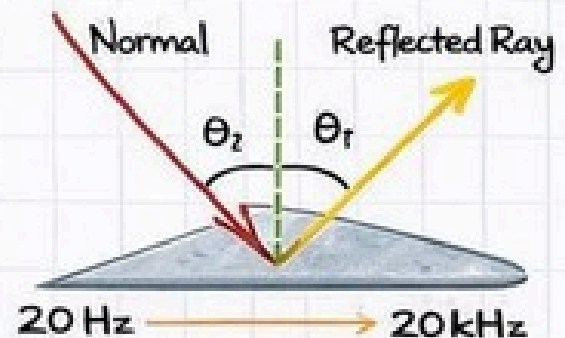- Megaphones, horns, trumpets
- Stethoscope
- Surved ceilings in halls

SOUND

Quick Revision Guide

6. RANGE OF HEARING

Human Audible Range

- 20 Hz to 20,000 Hz (20 kHz)
- Children and some animals: up to 25 kHz
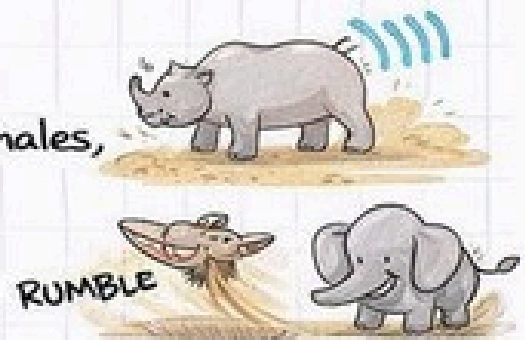- Sensitivity to higher frequencies decreases with age ▼

▶ Beyond Audible Range

Normal   Reflected Ray

θ_i θ_r

20 Hz ⟶ 20 kHz

Beyond Audible Range

- Infrasound < 20 Hz
  - Produced by: earthquakes, rhinos, whales, elephants

  Frequency = 20 Hz ⟶

RUMBLE

Beyond Audible Range

- Infrasound < 20 Hz
  - Produced by: bats, dolphins, porpoises

  Frequency > 20 kHz ⟶

Applications of Multiple Reflection
- Megaphones, horns, trumpets (direct sound in specific direction)
- Soundboards (reflect sound across auditorium)

SOUND

Quick Revision Guide

All the best!

7. APPLICATIONS & DISTINCTIONS

Applications of Ultrasound

Industrial Applications

- **Cleaning**: Removes dust/grease from hard-to-reach places using high frequency vibrations

- **Flaw Detection**: Detects cracks in metal blocks (ultrasound reflects from defects) →

Medical Applications

- **Echocardiography**: Images of heart
- **Ultrasonography**: Images of internal organs (liver, kidney, uterus, fetus)
- **Kidney Stone Treatment**: Breaks stones into fine grains
- **Hearing Aid**: Amplifies sound for hearing-impaired

Quick Problem-Solving Tips

- ★ For echo problems: Remember minimum 0.1 s gap and distance = $v \times \frac{T}{2}$
- ★ Use $v = \lambda v$ to find any one variable if two are known
- ★ For distance-time problems: time = distance / speed
- ★ Sound sensation persists in brain for 0.1 s

For echo problems: Remember minimum 0.1 s gap and distance = $\left(v \times \frac{t}{2} \right)$
- Use $v = \lambda v$ to find any one variable if two are known