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“What one man calls God, another calls the laws of physics.”

-Nikola Tesla

TOPIC 15: SOUND

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THE ABOUT

CHAPTER ANALYSIS

MASTERY

- Relatively easy topic
- Take note of echo questions and calculations

EXAM

- Tested in MCQ mainly, some Section A questions
- Closely linked to chapter like 'General Properties of Waves'

WEIGHTAGE

- Light overall weightage
- Constitute to around **2.5%** of marks for past 5 year papers

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KEY CONCEPT

SOUND WAVES
SPEED OF SOUND IN MEDIUM
ECHO

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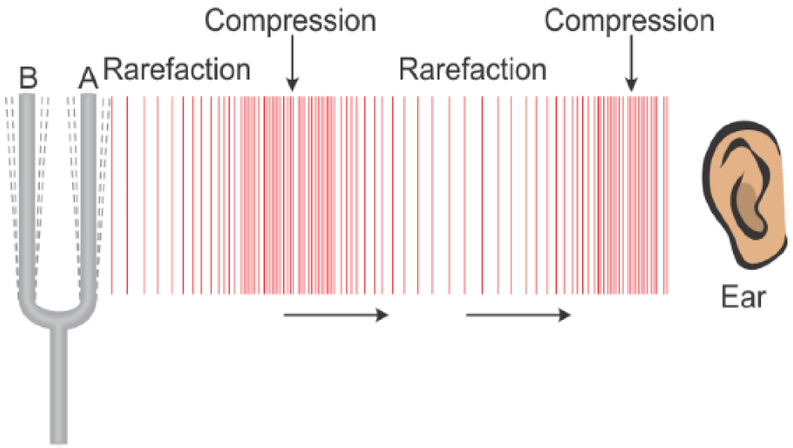
SOUND WAVES



When vibrating object alternately pulls or pushes on the layers of air adjacent to it, it causes small but rapid changes in air pressure.

Compressions are regions where particles are pushed closer together, resulting in higher pressure.

Rarefactions are regions where particles are pulled further apart, resulting in lower pressure.

SOUND WAVES

Sound waves are propagated as **longitudinal waves** whose particles vibrate parallel to the wave motion direction.

Sound waves are mechanical waves, as they require a **medium to travel**.

The source of a sound wave is by a **vibrating source.**

It can be produced by vibration of objects, eg drum, tuning fork, vocal cords.

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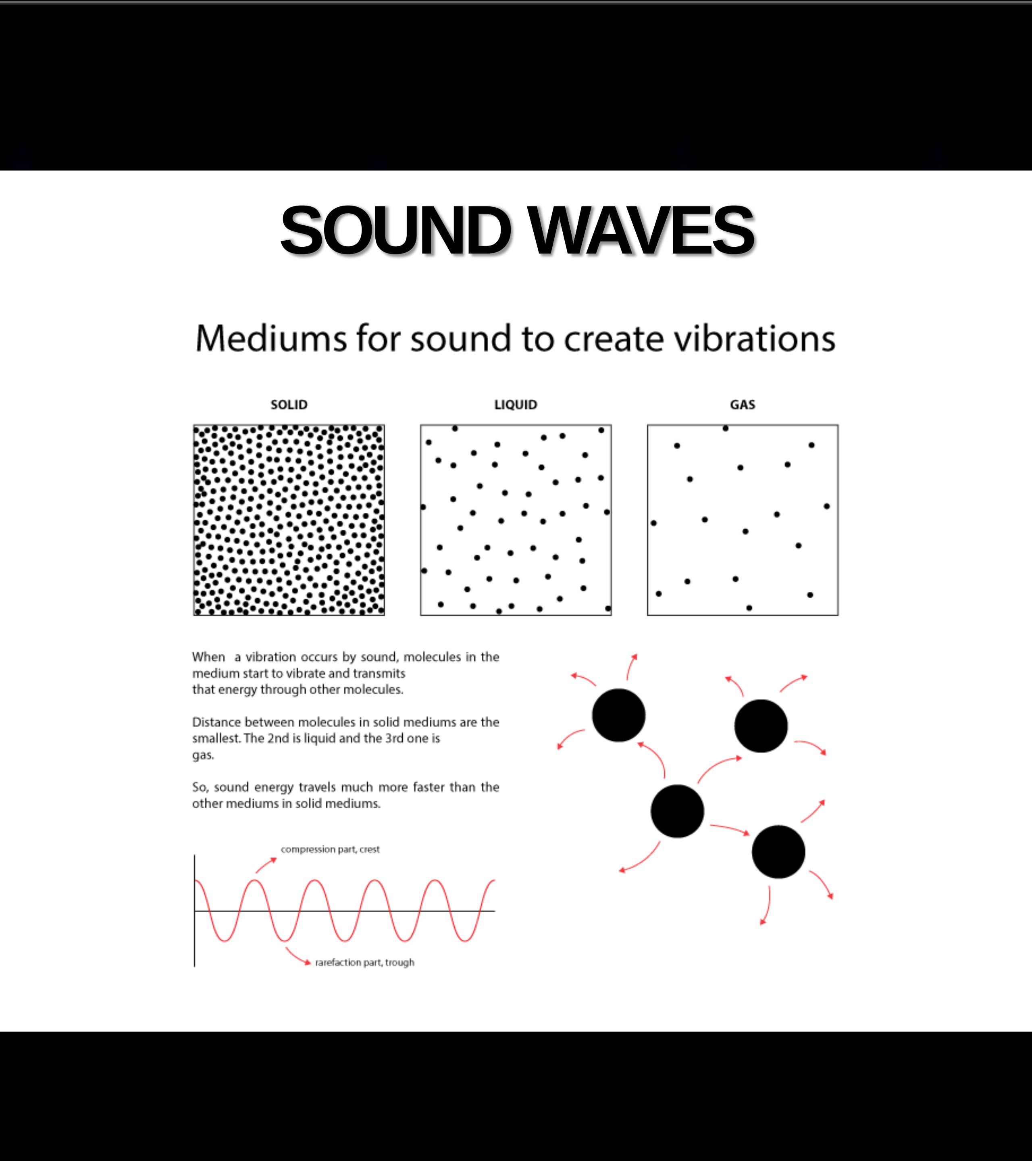

SPEED OF SOUND IN MEDIUMS

Sound travel faster in denser mediums as energy is transferred more quickly between particles.

Hence, sound travel fastest in **solid > liquid > gas.**

Medium	Speed / ms^{-1}
Vacuum	0*
Air	330
Water	1500
Steel	5200

***Sound does not travel in a vacuum.**

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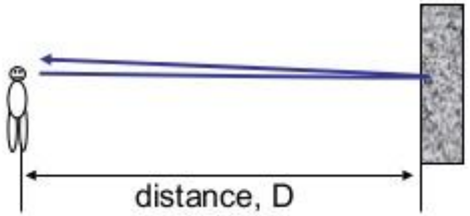
ECHO

Reflection of sound

An **echo** is a reflected sound wave.

Question:
A misguided child shouts 'Barca!' at a nearby cliff and hears an echo 1.4 s later. How far away is the cliff?
Take the speed of sound = 340 m/s.



The sound travels to and from the cliff, a total distance of 2D

speed = distance / time

becomes: ***distance = speed x time***

= 340 m/s x 1.4 s

= 476 m

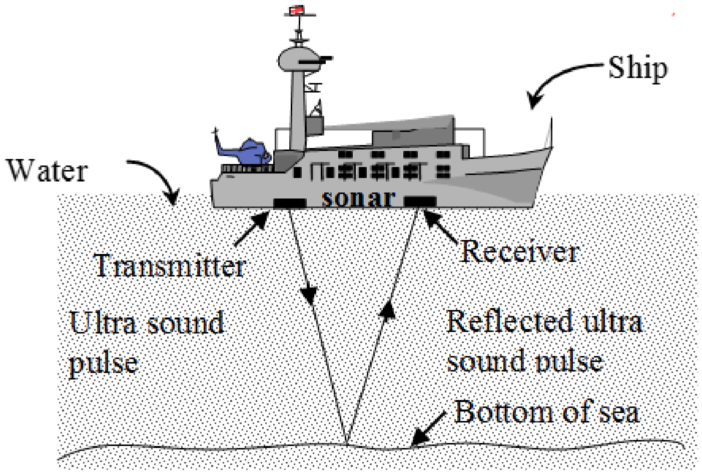
= 2D !

Therefore distance to the cliff = 238 m.

ECHO

When a sound wave is reflected by a large, hard and smooth surface, an echo is produced.

$$\text{Speed of sound} = \frac{\text{Distance}}{\text{Time}} = \frac{\text{Distance by echo to surface \& back}}{\text{Echo Time}}$$



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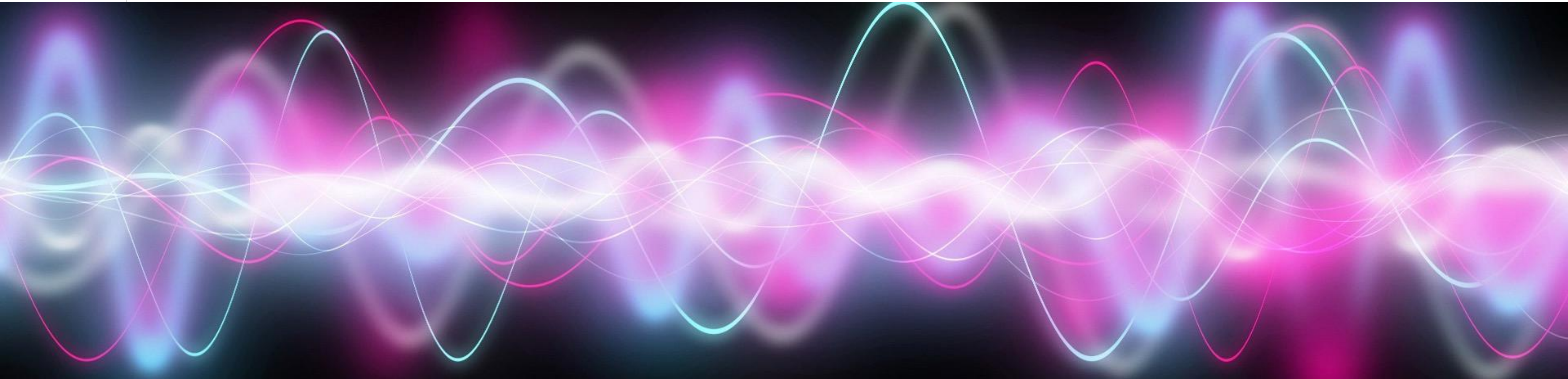
KEY CONCEPT

PITCH & LOUDNESS
C.R.O
ULTRASOUND



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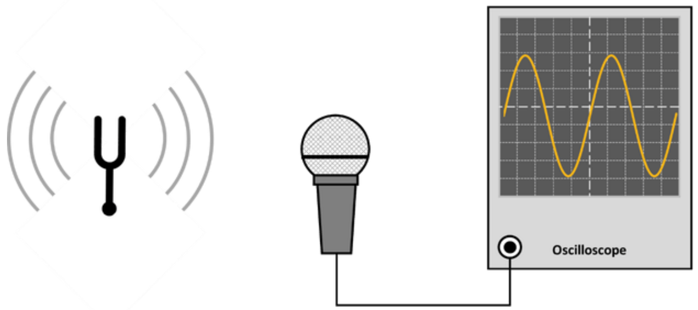
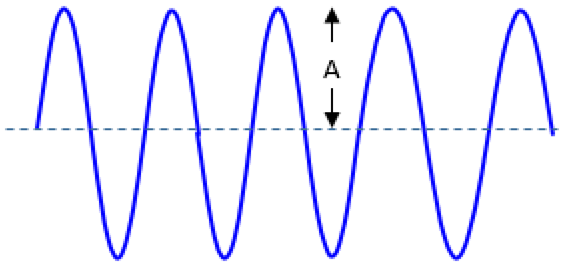


Used for displaying waveforms.

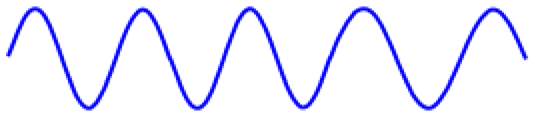
Y axis – voltage (amplitude)
X axis – time (frequency)

PITCH & LOUDNESS

Loudness is measured by amplitude & is a measure of the amount of energy carried by the sound.

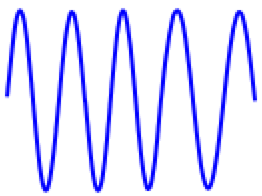


A loud sound – large amplitude

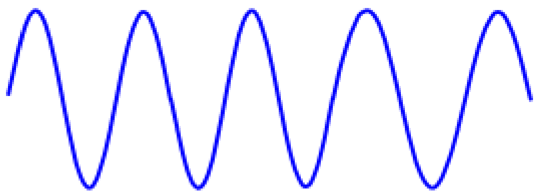


A soft (quiet) sound – small amplitude

Pitch depends on the frequency (number of waves formed in 1s).



A high pitched note – high frequency



A low pitched note – low frequency

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ULTRASOUND

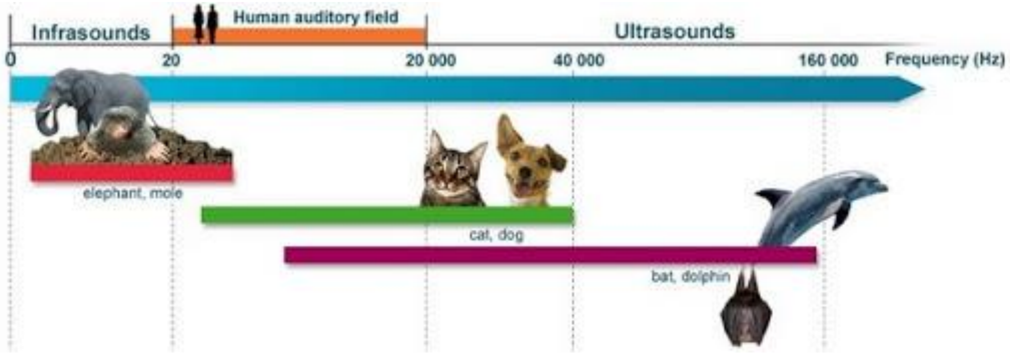
Ultrasound allows imaging because of the difference in time taken for the waves to return from different depths of the medium.

Application:

- Pre-natal scanning
- Sound navigation and ranging (sonar) to measure distances in air or water
- Quality control in manufacturing - detector monitors strength of ultrasonic signals

ULTRASOUND

An ultrasound is a type of sound wave that is **above 20kHz**.
Human audible frequency is between **20Hz and 20kHz**.



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