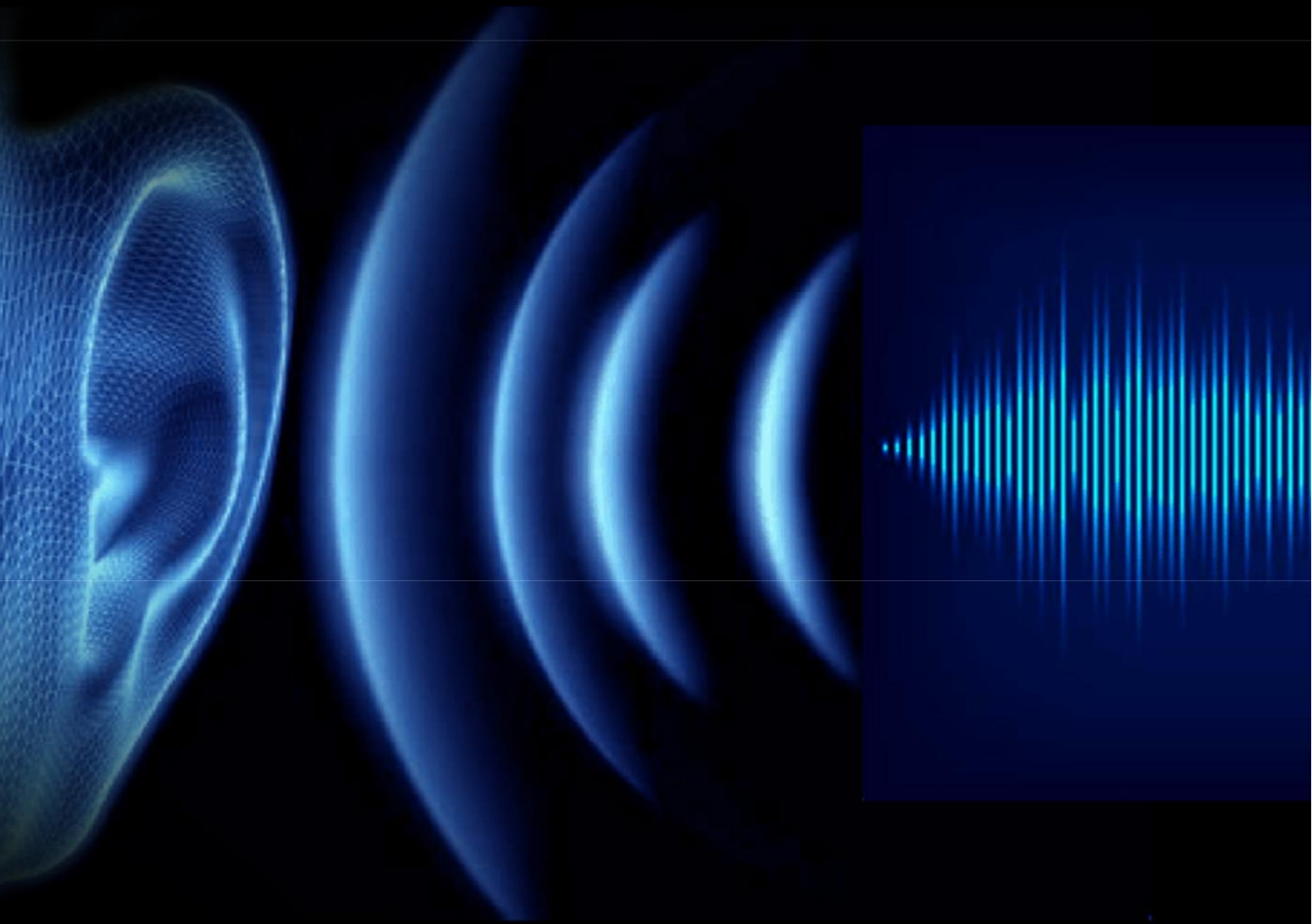
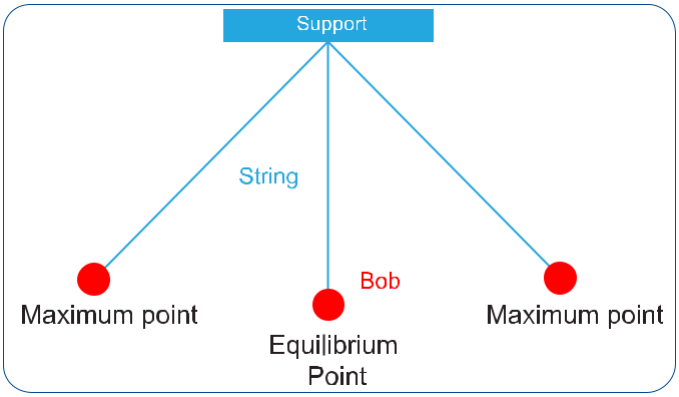
CHAPTER **(5)**

Waves and sound



The periodic motion:

- Simple harmonic motion: is the motion in which the restoring force is directly proportional to the displacement of the body from its mean position.
- Example: The motion of simple pendulum.



- Hook's law: states that the force needed to extend or compress a spring by some distance is proportional to that distance.

$$F = -kx$$

F is the force [N], K is the spring constant [N/m], x is the extension [m].

- Note: The minus sign means that the force is opposite to the motion.[restoring force].

- To determine the elastic potential energy that stored in a spring:

$$PE_{spring} = \frac{1}{2}kx^2$$

PE is the elastic potential energy for the spring [J], K is the spring constant [N/m], x is the extension [m].

Simple pendulum:

- Physical application: Determine the gravitational acceleration.

- Periodic time for the simple pendulum depends on: Length of string and the gravitational acceleration only. [Not the mass].

$$T = 2\pi\sqrt{\frac{l}{g}}$$

T is the periodic time [s], l is the length of string [m], and g is the gravitational acceleration [m/s²].

5.1 Which of these represents a simple harmonic motion?

A Clockwise rotation B Projectile movement
C Pendulum swing D Electrons movement

5.2 How much is the spring constant, if the extension is 20m, hanged on it a 20kg object, (knowing that gravitational acceleration is 9.8m/s²)?

A 9.8 N/m B 392 N/m
C 400 N/m D 980 N/m

Solution:

F = Kx
K = F/x = weight/x = 20x9.8/20 = 9.8 N/m
, the answer is A.

5.3 When comparing between the stored energy in a spring compressed for 0.4 m with the stored energy in the same spring compressed for 0.2m, the stored energy is…....

A Twice large when the spring compressed for 0.2 m
B Twice large when the spring compressed for 0.4 m
C 4 times large when the spring compressed for 0.2 m
D 4 times large when the spring compressed for 0.4 m

5.4 A spring constant is 400 N/m, affected by a force that makes it extend, so its potential energy is 50J, the extension of spring is…

A 4 m B 2 m
C $\frac{1}{2}m$ D $\frac{1}{4}m$

Solution:

PE = 1/2 Kx² = 1/2 (400) x²
50 = 200 x²
X² =50/200 =1/4
X = 1/2 m , So the answer is C.

5.5 A simple pendulum, its string's length l equals the gravitational acceleration g, the periodic time for the pendulum is …

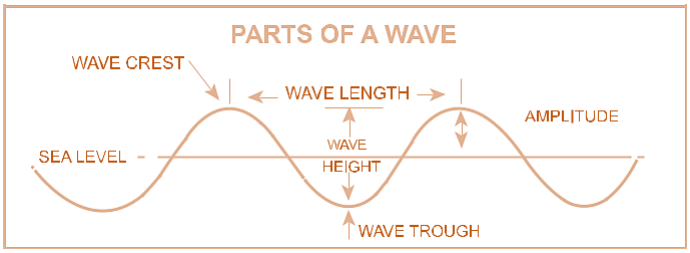
A π B 2π C $2\pi_2$ D $4\pi^2$

5.6 A 1kg mass hanged on a simple pendulum, the periodic time is 3s, if we change the mass with 2kg mass, then change it again with 3kg mass, so the periodic time in the two changes will be.

A 3 s, 3 s B 6 s, 6 s C 6 s, 9 s D 2 s, 1 s

Waves:

- A wave is a continuous and repeating disturbance of a medium and a pulse is a single disturbance.
- The amount of energy that carried by the wave depends on(directly proportional to) the amplitude squared.
- Types of waves:
  1. Mechanical waves: which need medium to move in or translate. As: sound and water waves.
  2. Electromagnetic waves: don't need medium to trans-late as light.
- Amplitude: The maximum displacement from the equi-librium position.
- Periodic time: time needed to complete one full cycle.
- Frequency: number of complete cycles in one second.
- f is the frequency [Hz], T is the periodic time [s]
- Wavelength: is the distance between two consecutive crests or troughs.



Speed of waves:

$$v = \frac{d}{t}$$

V is the speed of wave [m/s], d is the distance [m], t is time [s].

- In the case of echo the distance travelled by sound is double the distance between the source and the bar-rier, so needs to divide by 2.
- The relation between wavelength and frequency is giv-en as:

$$\lambda = \frac{v}{f}$$

is the wavelength [m] v is the wave's speed [m/s], f is the frequency [Hz]

- The wavelength is inversely proportional to frequency.
- In electromagnetic waves the speed of waves is equiv-alent to speed of light .

5.7 A disturbance moves.

A Frequency B Wave
C Amplitude D node

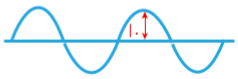
5.8 The amount of energy that carried by the wave directly proportional to the .

A speed B Speed squared
C Amplitude D amplitude squared

5.9 The maximum displacement from the equilibri-um position in mechanical waves is.

A Wave amplitude B Wave length
C Wave frequency D Wave antinode

5.10 The distance L on the diagram represents.



A Wave amplitude B Periodic time
C Frequency D Wave length

5.11 The time needed to complete one full cycle (crest- trough) is.

A Half life B Frequency
C Acceleration D Periodic time

5.12 The number of complete cycles in one second is.

A Periodic time B phase
C Wave length D frequency

5.13 **A spring swings 60 times in 20 s, so its frequency is.**

A 1/3 B 1/6 C 3 D 12

5.14 **The periodic time of a10 Hz wave equals.**

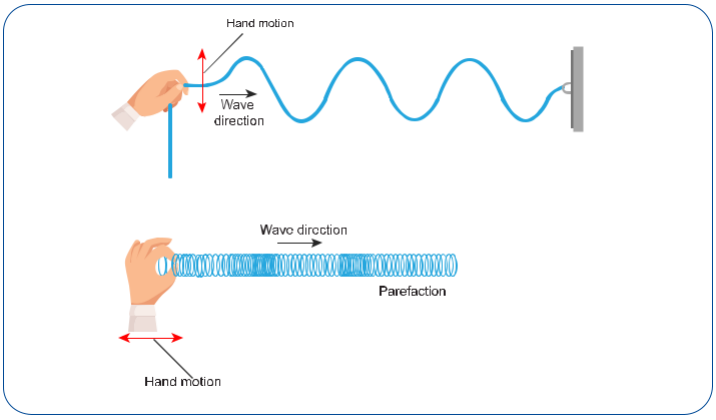
A 100 s B 1 s C 0.1 s D 0.01 s

5.14 **The wave length symbol is.**

A *a* B *s* C *l* D *d*

Mechanical waves:

- The transversal waves: cause the medium to move perpendicular to the direction of the wave.
- The longitudinal waves: cause the medium to move parallel to the direction of the wave.
- Surface waves: the wave that moves parallel and perpendicular to the direction of the wave.



Motion of waves can be classified into 3 types:

- One dimension: The wave of the rope and spring.
- Two dimensions: water's waves
- Three dimensions: Sound waves and electromagnetic waves

5.16 **The distance between A and B shows.**

A $\frac{1}{4}\lambda$ B $\frac{1}{3}\lambda$ C $\frac{1}{2}$ D λ

5.17 **A sound wave 200Hz frequency travels 100m distance in 0.5 s, its wave length is.**

A 4m B 2m C 1m D 0.5m

Solution:

$$c = f\lambda$$

$$\frac{100}{0.5} = 200\ \lambda$$

$200 = 200\lambda$ λ = 200/200 = 1 m, so the answer is C

5.18 **Ahmad shouted out loud towards a mountain, 510 m far, he heard his echo after 3s, how much is the sound speed in air? (m/s)**

A 340 B 300 C 200 D 140

5.19 **If a wave's speed is 6m/s, its length is 0.5m, how much is its frequency?**

A 0.6 Hz B 3 Hz C 6 Hz D 12 Hz

5.20 **A length of an electromagnetic wave (travels in air) is $2\times10\,sm$, calculate its frequency [Hz], know that light's speed in vacuum is $3\times10\,m/s$ $2\times10\,sm$ calculate its frequency [Hz], know that light's speed in vacuum is $3\times10\,m/s$**

A 6.7×10^{-17} B 15×10^{-15}
C $15\times10_{15}$ D 6.7×10^{17}

Solution:

$$c = f\lambda$$

$$f = \frac{c}{\lambda} = \frac{3\times10^{8}}{2\times10^{-8}} = 1.5\ x10_{16} = 15\ x\ 10_{15}\ Hz$$, so the answer is C

5.22 **A disturbance where molecules vibrate in an orthogonal direction with disturbance line is.**

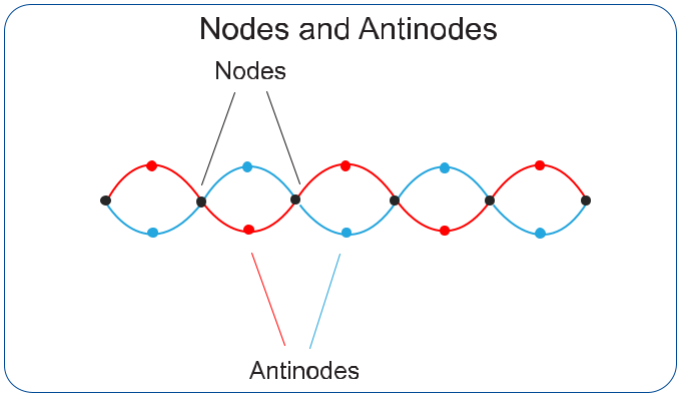
A Longitudinal waves B Sound waves
C Longitudinal mechanical waves D Transversal mechanical waves

5.13 One type of two dimensional waves is.

A Rope B Spring C Water D Sound

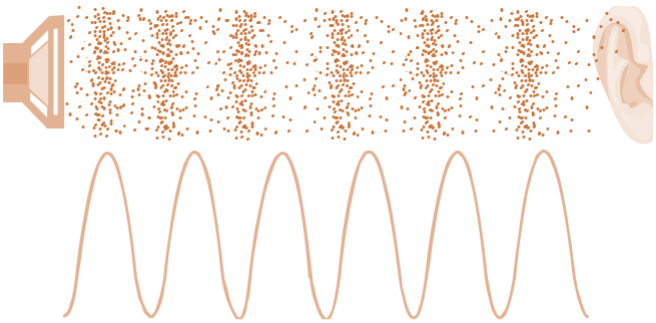
Standing waves:

- Standing waves is a combination of two waves moving in opposite directions, each having the same amplitude and frequency.
- In standing waves number of nodes is greater than an-tinodes.



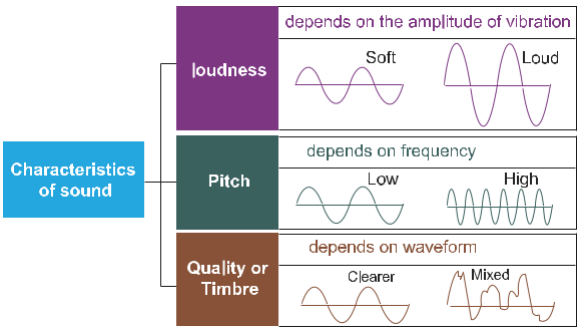
Sound waves:

- A wave of compression and rarefaction, by which sound is propagated in an elastic medium such as air.
- Sound waves are longitudinal waves.
- Sound waves need medium to translate.
- Speed of sound in air depends on its temperature. (Directly proportional).
- Speed of sound in liquids is greater than speed of sound in gases, and less than speed of sound in solids.



Characteristics of sound:

- Loudness: depends on the amplitude of the sound waves.
- Pitch: depends on the frequency of sound waves.
- Sound intensity level: the relative sound intensity at any point in a sound field as compared with a specified stand-ard intensity that is usually expressed in decibels above or below the standard. (Logarithmic scale).
- Human mostly can hear the sounds that has frequency between 20 to 20000 Hz. Not less than 20 Hz or more than 20000. Hz.



5.24 An example of three dimensions waves is.

A Sound waves B Water waves
C Rope waves D Spring waves

5.25 The standing waves which exist due to a combination of two opposite directions waves is.

A Reflected waves B Incident waves
C Surface waves D Standing waves

5.26 In the standing waves, the number of nodes is ……. the number of antinodes

A greater than B less than
C equals D doubles

5.27 The sound moves from the source to the listener due to.

A The change in air density B The change in air pressure
C The change in air speed D The change in air temperature

5.28 The sound speed in air depends on.

A loudness B Sound level
C Wave amplitude D temperature

5.29 Sound pitch depends on.

A Sound frequency B Sound speed
C Sound level D loudness

5.30 Most human can hear the sounds that has frequency of …….. Hz.

A 20 - 200000 B 20 – 20000
C 2 – 20000 D 2-200

5.31 A Logarithmic scale to measure sound level is.

A Sound degree B Sound intensity
C Sound waves D Sound pitch

5.32 Sound intensity unit is.

A Decibels B Hertz
C Joule D Watt

Doppler Effect:

- The Doppler Effect, or Doppler shift, describes the changes in frequency of any kind of sound or light wave produced by a moving source with respect to an observer. Or moving observer or both.

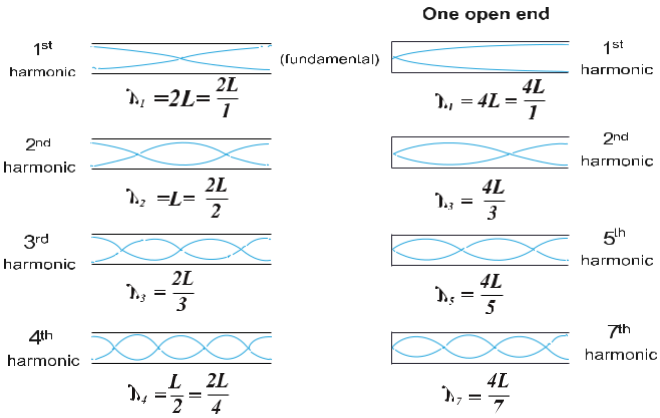
$$f_o = f_s\left(\frac{v \pm v_o}{v \pm v_s}\right)$$

fo is detected frequency or observed frequency [Hz], fs is the source frequency [Hz], v is the speed of wave [m/s], vo is the speed of detector or observer [m/s], vs is the speed of source [m/s].

- Applications: The radar, bats, determine speed of galaxies,

Resonance in air columns:

The relation between the wavelength and the length of column:



- In two open ends columns: Number of antinodes is greater than the nodes.
- In one open end columns: Number of nodes and antinodes are equivalent.

5.33 The change in frequency of sound as a result of its source moving.

A Compton Effect B Sound Diffraction
C Doppler Effect D Sound Echo

5.34 Two cars are moving at same speed and direction, if the trumpet of the first car sound-ed 450Hz, how much the frequency does the second car driver hear? (knowing that sound velocity 343 m/s)

A 343Hz B 450Hz
C 107Hz D 900Hz

5.35 The Radar is an application of.

A Pascal Principle B Doppler principle
C Bernoulli principle D Compton principle

5.36 A first harmonic occurs in a closed column its length is 0.5m , makes 150 Hz sound, the speed of sound is…….. m/s

A 150 B 200 C 250 D 300

Solution:

λ = 4L = 4x 0.5 = 2 m
c = λf = 2 x 150 = 300 m/s , so the answer is D

5.37 **How much is the frequency at second harmonic in a one closed end column, its length is 15cm? (Knowing that sound velocity 343 m/s)**

A 2287 B 1143 C 1715 D 572

5.38 **The number of antinodes in the open air column is …….. the number of nodes.**

A greater than B less than
C equals D double

Answers : Chapter 5

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
C	A	D	C	B	A	B	D	A	A	D	D	C	C	C	D	C	A	D	C

21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
B	D	C	A	D	A	B	D	A	B	B	A	C	B	B	D	C	A