Sound

Sound is a wave caused by the movement of particles that travels through air or water similar to the ripples on a pond or the ocean waves you might see on a beach. A wave can be described as a disturbance that travels through a medium from one location to another location is called wave. There are two types of waves: Mechanical waves and electromagnetic waves.

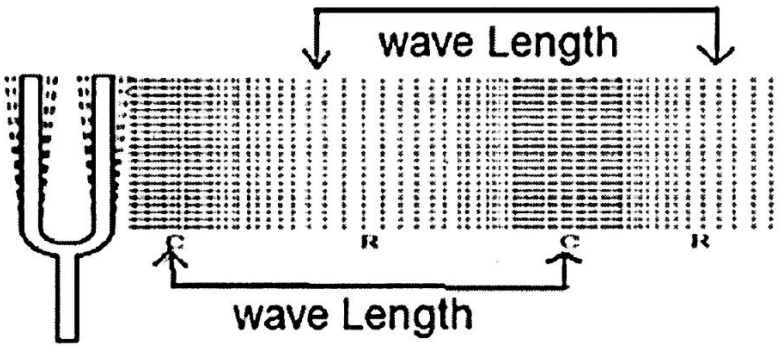
Electromagnetic Waves

Electromagnetic waves are waves travelling through a vacuum and do not require a medium in order to transport their energy (propagation) e.g. Light.

Mechanical Waves

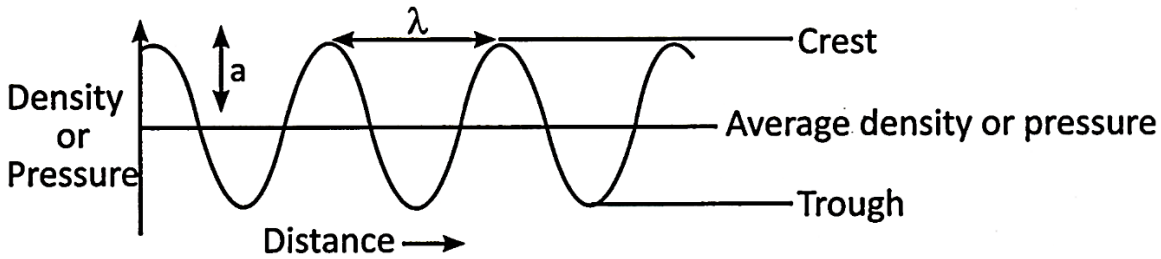
'Mechanical waves are waves which require a medium for propagation or to transport their energy from one point to another. It is of two types.

Longitudinal Wave: A mechanical waves in which the particles and the energy move in the same direction, parallel to the direction in which the wave is travelling.
A sound wave travelling through air is the example of longitudinal waves. Because particles of the medium through which the sound is transported, vibrate parallel to the direction to which the sound wave moves.



Compressions are the regions where particles are crowded together. The peak represents the region of maximum compression. Thus, compressions are regions where density as well as pressure is high.
Rarefactions are the regions of low pressure where particles are spread apart. The distance between two consecutive compressions (C) or two consecutive rarefactions (R) is called the wavelength. The wavelength is usually represented by A (Greek letter lambda). Its SI unit is meter (m).

Transverse wave: A wave in which particles of the medium move in a direction perpendicular to the direction to which the wave is travelling. The particles of medium vibrate up-and-down and the energy moves left-and-right. e.g. Water waves on the ocean surface.
A peak is called the crest and a valley is called the trough of a wave.



Propagation of Sound

The matter or substance through which sound is transmitted is called a medium. It can be solid/ liquid or gas.

We can describe a sound wave by its properties:

(a) Frequency (b) amplitude and (c) speed.

The number of such oscillations per unit time is the frequency of the sound wave. If we can count the number of the compressions or rarefactions that cross us per unit time, we will get the frequency of the sound wave. It is usually represented by **n.** Its SI unit is hertz **(Hz).**

The time taken for one oscillation is called time period. It is represented by the symbol T. Its SI unit is second (s).

Frequency and time period are related as follows: $n = 1/t$

Pitch: How the brain interprets the frequency of an emitted sound is called the pitch. The faster the vibration of the source, the higher is the frequency and the higher is the pitch.

The amplitude of the sound: The magnitude of the maximum disturbance in the medium on either side of the mean value is called the amplitude of the wave. It is usually represented by the letter A. The amplitude of the sound wave depends upon the force with which an object is made to vibrate.

The quality or timber of sound is that characteristic which enables us to distinguish one sound from another having the same pitch and loudness. The sound which is more pleasant is said to be of a rich quality.

Notes and tone: A sound of single frequency is called a tone. The sound which is produced due to a mixture of several frequencies is called a note.

Noise and music: The sound which is pleasant to listen is called music. The sound which is unpleasant to listen is called noise.

The speed of sound: The distance (a compression or a rarefaction) travels per unit time is called the speed of sound.

Speed, v = distance/time = wave length/time $= \mathrm{I}/\mathrm{T} = \mathrm{I} \times (1/\mathrm{t})$ Or, $\mathrm{v} = \mathrm{nl}\,(\text{as } \mathrm{n} = 1/\mathrm{T})$

$\text{Speed} = \text{wavelength} \times \text{frequency}$

Commonly Asked Questions

- A body is moving along a circular path of radius r. What is the distance and the displacement of the body when it completes half a revolution?

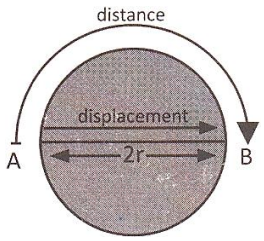
  (a) 2r (b) 3r

  (c) 4r (d) 1r

  (e) None of these

  Answer (A)

  Explanation: If we travel from the starting in point A along a circular track of radius r and reach halfway at point B, then distance



  Distance travelled $= 1/2 \times 2\,r = \pi r$

  [$\because$ Circumference of a circular track Is 2π r.]

  Displacement, AB $= 2$r

- During an experiment, a signal from a spaceship reached the ground station in five minutes. What was the distance of the spaceship from the ground Station? The signal travels at the of light, i.e. $3 \times 10^8 m/s$.

  (a) $8 \times 10^{10} m$ (b) $9 \times 10^{10} m$

  (c) $9.2 \times 10^{10} m$ (d) $7 \times 10^{10} m$

  (e) None of these

  Answer (B)

- **Explanation:** Speed of the signal (equal to speed of light.)

  $(v) = 3 \times 10^8$ m/s

  Time taken (t) = 5 minutes $= 5 \times 60s$

  Distance (s) =?

  Distance travelled

  $$\text{we know, Speed} = \frac{\text{distance trvelled}}{\text{Time taken}}$$

  Or $S = v \times t$

$= 3 \times 10^8 \text{ m/ s} \times 5 \times 60 \text{ s}$

$= 900 \times 10^8 m$

$= 9 \times 10^{10} m$

Thus, the distance of the spaceship from the ground station is $9 \times 10^{10} m$

- An artificial satellite is constantly moving in a circular orbit of radius 42250 km. Calculate its speed if it takes 24 hours to revolve around the earth (calculate its speed in km/s).

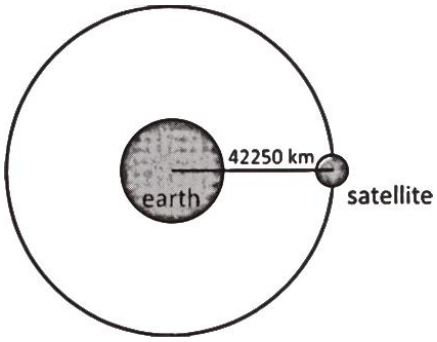
(a) 2.07 km/s (b) 1.07 km/s

(c) 3.07 km/s (d) 4.07 km/s

(e) None of these

Answer (C)

Explanation: Radius of circular orbit (r) = 4.2250 km



∴ Distance travelled in one revolution around the earth

$= 2\pi r = 2 \times \frac{22}{7} \times 42250 \ km$

Time taken to revolve around the earth

$= 24h$

$= 24 \times 60 \times 60 s$

$\text{We know, speed} = \frac{\text{Distance travelled}}{\text{Time taken}}$

$= \frac{2 \times \frac{22}{7} \times 42250 km}{24 \times 60 \times 60 m}$

$= 2 \times \frac{22}{7} \times \frac{42250}{24 \times 60 \times 60}$

$= 3.07 \ km / s$

Thus, the speed of the artificial satellite revolving around the earth is 3.07 km/s.

- A scooter acquires a velocity of 36 km/h in 10 seconds, just after the start. Calculate the acceleration of the scooter.

(a) $1\,m/s^2$ (b) $3\,m/s^2$

(c) $2\,m/s^2$ (d) $4\,m/s^2$

(e) None of these

Answer: (A)

Explanation: Initial velocity (u) = 0 km/h

(scooter starts from rest)

Final velocity (v) = 36 km/h

$$= \frac{36 \times 1000\,m}{60 \times 60\,s} = 10 m/s$$

$$\text{Time}(t) = 10\,s$$

We know,

$$\text{Acceleration } (a) = \frac{v - u}{t}$$

Putting the given values in the above formula, we get

$$a = \frac{10\,m/s - 0\,m/s}{10\,s}$$

$$= \frac{10\,m/s}{10\,s} = 1$$

Thus, the acceleration of the scooter is $1\ m/s^2$.

- What is the acceleration produced by a force of 12 N exerted on an object of mass 3 kg?

(a) $1\,m/s^2$ (b) $4\,m/s^2$

(c) $2\,m/s^2$ (d) $6\ m/s^2$

(e) None of these

Answer: (B)

Explanation:

Force (F) = 12 N

Mass (m) = 3 kg

Acceleration (a) = ?

By using the formula, $F = m \times a$, we get

$$12\,N = 3\,kg \times a$$

$$a = \frac{12\,N}{3\,kg} = \frac{12\,kgm/s^2}{3\,kg}$$

$$a = 4\ m/s^2$$

Thus, the acceleration produced in the object is $4\ m/s^2$.