Velocity Of a Pulse In Slinky – Experiment, Viva Voce

EXPERIMENT

Aim
To determine the velocity of a pulse propagated through a stretched string/slinky.

Theory

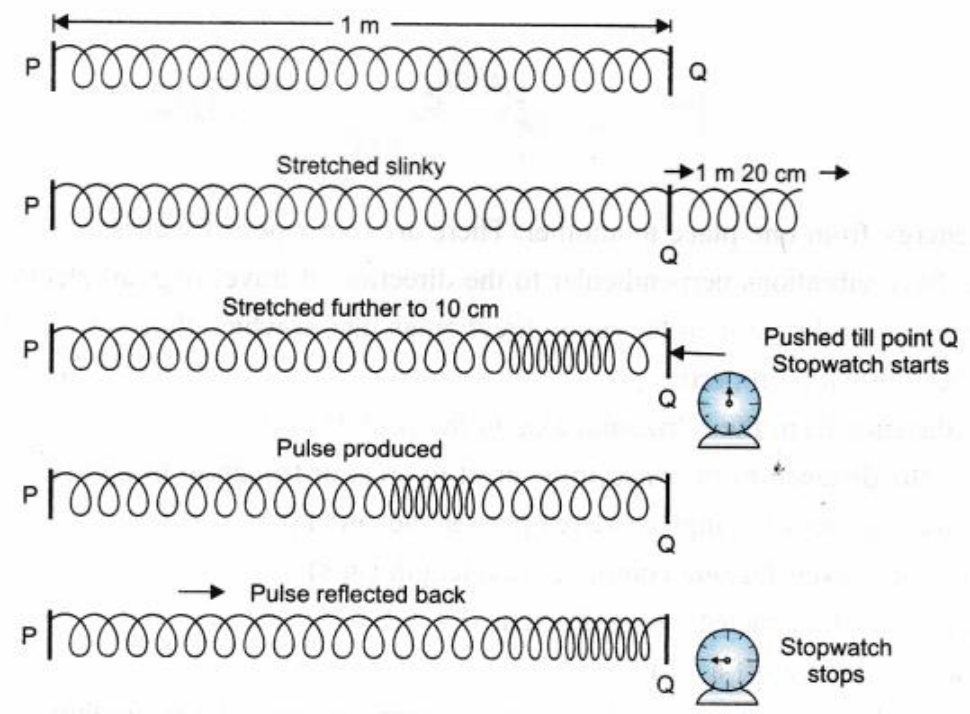
1. **Wave:** A wave is a disturbance that moves through a medium when the particles of the medium set neighbouring particles into motion by transfer of energy.
2. **Slinky:** A slinky is a long spring which is flexible and has appreciable elasticity.
3. **Pulse:** A wave produced by a single disturbance in a medium is known as pulse.

Velocity of pulse = $\frac{Total\ \ distance\ \ travelled\ \ by\ \ pulse}{Total\ \ time\ \ taken}$

Materials Required
A slinky with flat wire made up of metal/plastic should be atleast 1 m long, a metre scale, a stop-watch, a marker/ chalk.

Procedure

1. Mark a point on the floor of a long corridor. Let this point be P.



2. From point P measure the distance of 1 m with the help of metre scale, mark this point as Q.
3. Allow one student to hold one end of slinky at point P.
4. Let another student stretch the slinky and bring it at point Q.
5. Let third student hold the stopwatch.
6. The student who has stretched the slinky will stretch it beyond point Q and then give a sharp push towards point Q. The push should stop at point Q.
7. A pulse is produced in the slinky which travels towards the point P and it gets reflected back towards point Q.
8. Record the time from push at Q to the pulse travelling towards P and back at Q.
9. Follow the above procedure 56 times and record your observation
10. Calculate the velocity of pulse by the formula

Velocity of pulse = $\frac{Total\ \ distance\ \ travelled\ \ by\ \ pulse}{Total\ \ time\ \ taken}$

$v = \frac{2d}{t}$

Observation Table

S.No.	Length of stretched slinky	Total distance travelled by Pulse 2(d)	Time taken (t)	Velocity of pulse $v = \frac{2d}{t}$
1.	1 m	2 × 1 m = 2 m	11.34	0.176
2.	1 m	2 × 1 m = 2 m	10.08	0.198
3.	1 m	2 × 1 m = 2 m	10.56	0.189
4.	1 m	2 × 1 m = 2 m	11.46	0.174
5.	1 m	2 × 1 m = 2 m	10.86	0.184

Average velocity of pulse = $\frac{0.176+0.198+0.189+0.174+0184}{5}$ = 0.1842

Result

The velocity of pulse = 0.1842 m/s.

Precautions

1. Slinky used should be of good quality and with even springs coiled all over.
2. Accurately measure the distance and time.
3. The push at the end should be forceful to see the pulse and get the reflected wave back.
4. The slinky should not have any knot or kink at any point along its length.

VIVA VOCE

Question 1:

Define wave-motion.

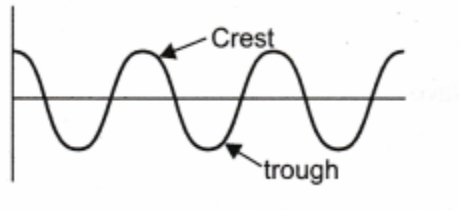
Answer:
A wave is a disturbance that moves through a medium when the particles of the medium set neighbouring particles into motion by transfer of energy.

Question 2:
Define pulse.
Answer:
A wave produced by a single disturbance in a medium is known as a pulse.

Question 3:
What is a slinky?
Answer:
A slinky is a long flexible spring.

Question 4:
Which wave needs medium for propagation?
Answer:
Longitudinal wave.

Question 5:
Show crest and trough in a wave with diagram.
Answer:



Question 6:
What is tone?
Answer:
The sound of single frequency is called tone.

PRACTICAL BASED QUESTIONS

Question 1:
State two types of wave motion.
Answer:

1. Longitudinal wave
2. Transverse wave.

Question 2:
How do particles of a medium oscillate in longitudinal waves?
Answer:
In longitudinal wave motion the particles of medium and wave both travel in the same direction.

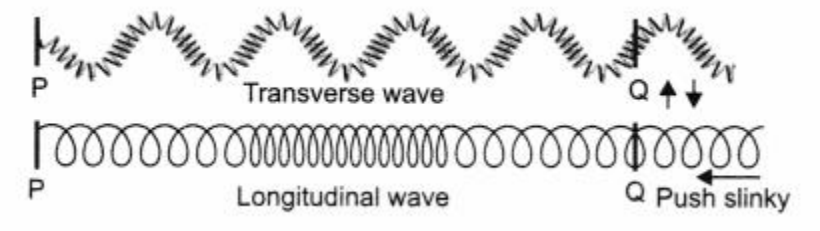
1. ⟶ wave motion
2. ⟶ particle motion

Question 3:
Give one example of pulse produced in daily life.
Answer:
When a stone is dropped in a pool of water it produces ripples i.e. the pulse.

Question 4:
How do particles of medium propagate in transverse wave?
Answer:
In transverse wave the particles of medium oscillate at right angles to the direction of wave propagation.

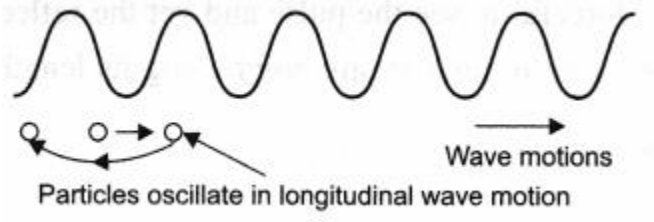
Question 5:
Give one difference between a wave and a pulse.
Answer:
A pulse is a short disturbance in a medium and is not continuous and a wave is a continuous disturbance in a medium which repeats after a regular interval of time.

Question 6:
What kind of wave-motion can be produced by a slinky?
Answer:
A slinky can produce both longitudinal and transverse wave.



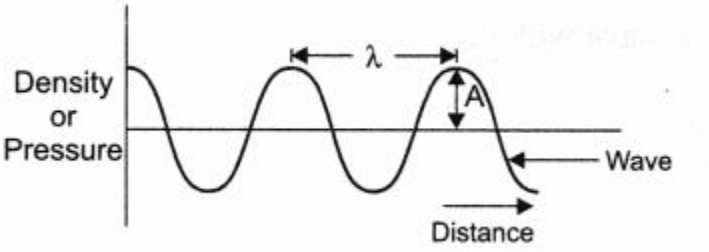
Question 7:
In longitudinal wave we say that particles of medium move in direction of the wave motion. Is this statement true?
Answer:

The particles of the medium oscillate to and fro in the direction of wave motion.



Question 8:
In transverse wave do the particles move in perpendicular direction to the wave motion?
Answer:
The particles in transverse wave motion only oscillate in perpendicular direction to the wave.

Question 9:

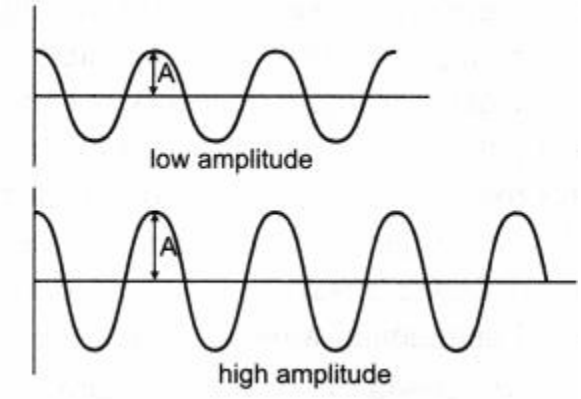


Represent a wavelength and amplitude in a wave.
Answer:

λ= wavelength = distance between two consecutive crests/troughs. S.I. unit is metre (m).
A = amplitude = the maximum distance the particle oscillates from its mean position is called its amplitude.

Question 10:
Represent a wave with low and high amplitude.

Answer:



Question 11:
What is the frequency of a sound wave?
Answer:
The number of compressions or rarefactions that cross a fixed point per unit time is called frequency of the sound wave. It is represented by v, its S.I. units is hertz (Hz).

Question 12:
What is time period of the sound wave?
Answer:
The time taken by two consecutive compressions or rarefactions to cross a fixed point is called the time period of the wave. It is represented by T. Its S.I. unit is second (s).

Question 13:
How is speed, wavelength and frequency of a sound wave related?
Answer:
$\nu = \lambda v$
Speed = wavelength x frequency
$\nu = \lambda / T$

Question 14:
A spring balance is suspended with a weight, when you remove the weight a wave is produced in the spring, what type of wave is this?
Answer:
It is the longitudinal wave.

MULTIPLE CHOICE QUESTIONS (MCQs)
Questions based on Procedural and Manipulative Skills

Question 1:
The wave produced on vibrating a tuning fork is
(a) transverse wave

(b) longitudinal wave
(c) electromagnetic wave
(d) tone wave.

Question 2:
A drummer beats the drum loudly the loud sound wave produced have
(a) small amplitude
(b) large amplitude
(c) single frequency
(d) high speed.

Question 3:
A sound wave is a longitudinal wave because
(a) the particles of medium travel parallel to wave motion
(b) the particles of medium move in perpendicular direction to the wave
(c) it can travel in any medium
(d) it causes compressions and rarefactions.

Question 4:
The compressions and rarefactions occur in sound wave due to
(a) different pressure
(b) different amplitude
(c) different density
(d) both (a) and (c).

Question 5:
If V is the speed of sound, 'A.' is the wavelength, then frequency will be
(a) $\frac{\lambda}{v}$
(b) vxf
(c) $\frac{v}{\lambda}$
(d) vx λ

Question 6:
The speed of sound in aluminium at room temperature (25°C) is 6420 m/s. If the aluminium is heated then speed of sound
(a) decreases
(b) increases
(c) remain same
(d) none of these.

Question 7:
A single disturbance produced in a slinky is called
(a) wave
(b) tone

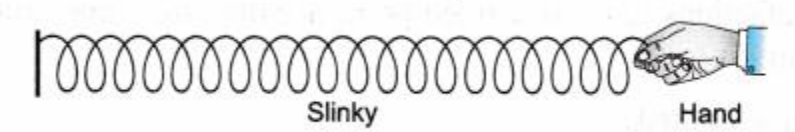
(c) pulse
(d) note.

Question 8:
The distance between two consecutive compressions/ rarefactions is
(a) $\frac{\lambda}{2}$
(b) 2λ
(c) λ
(d) $\frac{\lambda}{\nu}$

Question 9:
A pulse is produced in a rope whose one end is fixed by giving
(a) a single jerk at the free end
(b) more jerk at the free end
(c) continuous jerks at the free end
(d) it a strong pull at the free end.

Question 10:
To find the velocity of a pulse in a string, we need
(a) a measuring scale only
(b) only a stopwatch
(c) both (a) and (b)
(d) neither (a) nor (b).

Question 11:
A student sets up a slinky on a smooth table top in the manner shown here. He can produce a pulse in the slinky by giving a jerk to its free end; the jerk is given



(a) at an angle of 45° with the table top.
(b) backward and forward along the length of a slinky
(c) downwards
(d) towards left.

Question 12:
Four students while measuring the speed of pulse through a stretched string followed different procedures.
Student A stretched his thick cotton string very tight and gave it a very mild transverse horizontal jerk. Student B stretched his thin jute string just tight and gave it a mild transverse horizontal jerk.
Student C stretched his cotton string just tight and gave it a strong transverse horizontal

jerk.
Student D stretched his thin jute string very tight and gave it a strong transverse horizontal jerk.
Which student followed the correct procedure?
(a) A
(b) B
(c) C
(d) D

Question 13:
Short duration wave is called
(a) amplitude
(b) frequency
(c) pulse
(d) pitch.

Question 14:
With slinky you can produce
(a) only transverse wave
(b) only longitudinal wave
(c) both transverse and longitudinal wave
(d) none of these.

Question 15:
A sound wave is
(a) transverse wave
(b) longitudinal wave
(c) both (a) & (b)
(d) none.

Question 16:
A light wave is
(a) transverse wave
(b) longitudinal wave
(c) both (a) and (b)
(d) none.

Question 17:
The sound of single frequency is called
(a) pulse
(b) pitch
(c) tone
(d) frequency.

Question 18:
The wave that needs medium to travel is
(a) Transverse wave
(b) Electromagnetic wave
(c) Longitudinal wave
(d) none of these.

Question 19:
A wave produced by single disturbance in a medium is known as
(ia) tone
(b) pulse
(c) slinky
(d) Wave-motion.

Question 20:
In air (medium) and at room temperature the speed of sound is 345 m/s. If a tuning fork produces a pure tone of 1 kHz the wavelength of sound produced in air is
(a) 345 m
(b) 0.345 m
(c) 3.45 m
(d) 34.5 m.

Question 21:
The wave produced in the interior of the earth is called
(a) Light-wave
(b) Seismic wave
(c) Transverse wave
(d) Electromagnetic waves.

Question 22:
On which of the following factors the speed of propagation of pulse in a slinky does not depend?
(a) Dimension of slinky
(b) Material of slinky
(c) Room temperature
(d) Length of slinky

Question 23:
A pulse is formed
(a) in a small part of the medium
(b) in a large part of the medium
(c) in vacuum
(d) in all of the above.

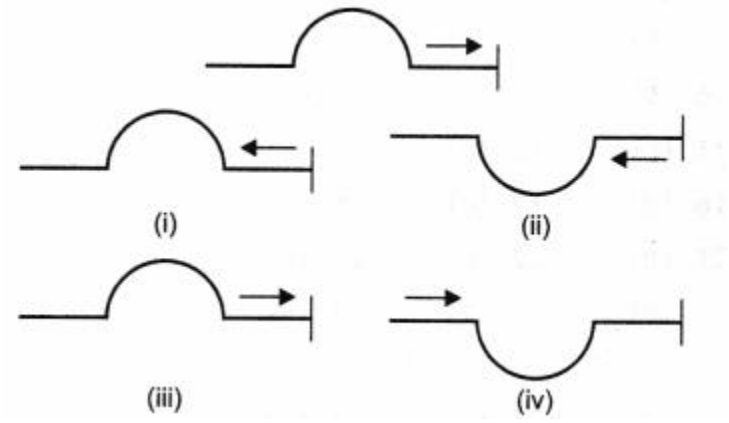
Question 24:
In case of transverse pulse created in slinky, every particles
(a) oscillates perpendicular to the length at slinky.
(b) gets displaced from one end to another
(c) does not oscillate.
(d) oscillates along the length of the slinky.

Question 25:
The string used should not be
(a) with very small amplitude
(b) stretched along the ground
(c) having knots
(d) all of the above.

Questions based on Observational Skills

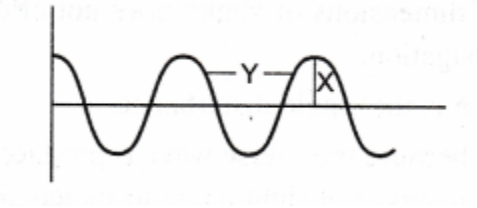
Question 26:
When you pluck the string of guitar you will observe
(a) longitudinal wave motion produced
(b) transverse wave motion produced
(c) both (a) and (b)
(d) none of these.

Question 27:
When a pulse produced in a string moves through it and strikes a rigid pole as shown in figure below, it is reflected back and the shape of the reflected pulse resembles the shape given as



(a) (i)
(b) (ii)
(c) (iii)
(d) (iv)

Question 28:
In the given wave 'X' & 'Y' represents



(a) Y= amplitude, X = wavelength
(b) Y= wavelength, X= amplitude
(c) X= crest, Y = trough
(d) X= wavelength, Y= crest.

Question 29:
A continuous disturbance in a medium which repeats after a regular interval of time is
(a) wave
(b) pulse
(c) wave-motion-frequency
(d) slinky.

Questions based on Reporting and Interpretation Skills

Question 30:
We can see flash of light in the space but cannot hear a person talking to you because
(a) light is electromagnetic wave and sound is mechanical wave.
(b) light has very high speed than sound.
(c) both (a) and (b)
(d) none of the above.

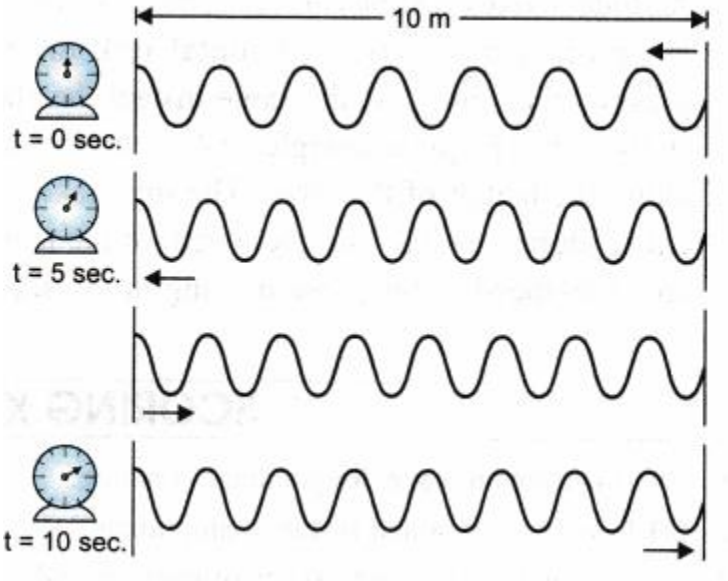
Question 31:
A pulse was created in a slinky/string of length 4 m by a group of students. They observed that it returned, after reflection, at the point of creation 6 times in 10 seconds and calculated the speed as follows:

Students	A	B	C	D
Speed m/s	0.4	2.4	4.8	9.6

The correct speed was calculated by the student
(a) A
(b) B
(c) C
(d) D.

Question 32:
The velocity of a slinky when stretched to 5 m is 2 m/s, if it is stretched to 8 m, its velocity will
(a) decrease
(b) increase
(c) remains the same
(d) becomes double.

Question 33:
A wave in slinky travelled to and fro as shown; the velocity of wave is

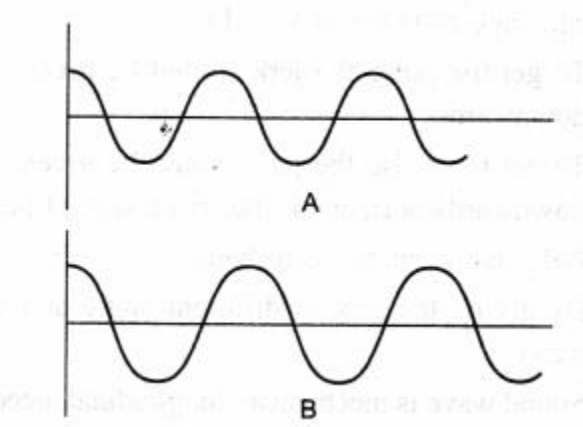


(a) 1 m/s
(b) 2 m/s
(c) 5 m/s
(d) 10 m/s.

Question 34:
When a pulse is sent through a slinky/string, the physical quantity that travels along its length is
(a) speed
(b) frequency
(c) wavelength
(d) energy.

Question 35:
The physical quantity that remains unchanged after reflection of sound wave is
(a) velocity
(b) wavelength
(c) frequency
(d) all of these.

Question 36:



A wave that shows low amplitude is
(a) A
(b) B
(c) both A & B
(d) none.

Question 37:
In a wave motion in string, every particle
(a) oscillates
(b) displaces from one end to the other end
(c) does not displace at all
(d) does not oscillate.

Question 38:
When a pulse is formed on a slinky
(a) the oscillations ‘stay on’ for a long time
(b) the slinky remains undisturbed
(c) slinky oscillates for short while
(d) a pulse moves along the length disturbing a small part at a time.

Question 39:
A student fixes a slinky to one end of smooth table. He gives a transverse horizontal jerk to create a pulse in the slinky. At the same instant, he starts his stopwatch. The pulse completes 4 to and fro journeys along the length of the table. The time taken for the entire journey is 2.8 sec. The length of the table is 25 cm. The speed of the pulse moving in the slinky is
(a) 1.4 m/s
(b) 0.7 m/s
(c) 0.3 m/s
(d) 0.28 m/s

SCORING KEY WITH EXPLANATION

1. (b) It is a sound wave, longitudinal in nature.
2. (b) Loudness of sound is due to amplitude.
3. (a) In sound waves the particles of medium and the wave propagation is parallel.
4. (d) Density and pressure variations cause propagation of sound.
5. (c) Frequency = velocity/wavelength.
6. (b) The molecules on heating gains energy and vibrates faster thereby increasing the speed of sound.
7. (c) Pulse is the single disturbance.
8. (c) The wavelength is the distance between two consecutive crests/ troughs.
9. (a) Pulse is the single disturbance.
10. (c) Stopwatch will calculate the time and scale will calculate distance as $V=\frac{d}{t}$.
11. (c) To get the pulse the jerk should be given upwards or downwards.
12. (c) To get the pulse the jerk should be given upwards or downwards/horizontal, the string should be tight.
13. (c) Pulse is the single disturbance.
14. (c) By giving the jerk in different angle and in different ways.
15. (b) Sound wave is mechanical, longitudinal, needs medium.
16. (a) Light wave needs to medium and is transverse wave.
17. (c) Tone is the sound of single frequency.
18. (c) Longitudinal waves are mechanical waves and need medium for propagation.
19. (b) Pulse is the single disturbance.
20. (b) Wavelength = $\frac{velocity}{frequency}$, = $\frac{345}{1000}$.
21. (b) Interior of earth produces seismic wave.
22. (a) The dimensions of slinky does not affect the speed of propagation.
23. (a) Pulse is the single disturbance.
24. (a) It is because transverse wave is produced when the free end is jerked at right angle to its length.
25. (d) If the amplitude of motion of the swinging pendulum is small, then the pendulum behaves approximately as a simple harmonic oscillator.
26. (c) On plucking the guitar sound wave is produced which is longitudinal wave and it vibrates as transverse wave.
27. (b) Alternate crest and trough.
28. (b) The maximum movement of particle from its mean position is amplitude and the distance between two consecutive crest/trough is wavelength.
29. (a) Wave is a continuous disturbance.
30. (a) Electromagnetic waves do not need the medium for propagation but mechanical waves need material medium for propagation.
31. (c) V = (8 x 6)/10 = 4.8
32. (b) Velocity is directly proportional to the distance travelled, if the distance increases the velocity also increases.
33. (b) V = $\frac{2d}{t}$, V =$\frac{20}{10}$ = 2.
34. (d) Energy travels through a wave.

35. (d) Velocity, frequency and wavelength remains the same for sound in same medium.
36. (a) The least distance travelled by a particle from its mean position gives low amplitude.
37. (a) The wave propagates and the oscillation of particles is produced.
38. (d) Pulse is the single disturbance.
39. (b) $4 \times \frac{0.5}{2.8} = 0.71$.