The City School

North Nazimabad Boys Campus

For class : 10/11

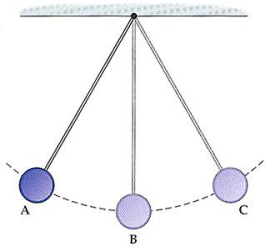
WAVES!

Introduction:

Hey again everyone! Hope you are all good. What comes to your mind when you think of waves? Umm sea waves? Yeah probably.

Definition:

To define a wave: it is made up of periodic motion. Now what is periodic motion? It is motion that is repeated at regular intervals. For example, a pendulum bob moving from one extreme end to the other and then back to it's starting position is said to be periodic. We'll use the term oscillation and vibration to describe periodic motion.



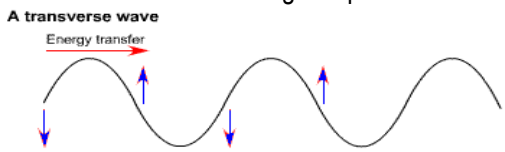
Can you tell me how a wave is produced? Okay how did the pendulum start? By an oscillation right? There! A wave is produced by any vibration or oscillation.It can be thought of as a travelling disturbance. But note that when a wave is formed, it transfers energy. No matter is transferred. Lets say you throw a stone in water, circular waves will move outwards on the surface of water. In this case also, energy is transferred.

Types of Waves:

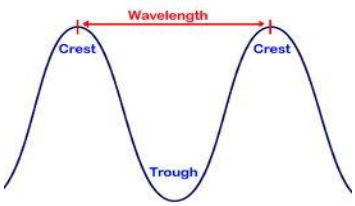
There are two types of waves: transverse and longitudinal.

Transverse waves:

- Transverse waves are waves that travel perpendicular to the direction of motion.
- Examples are rope waves and water waves.
- The crest is the highest points of the wave whereas the trough is the lowest points of the wave.



In the diagram above, the direction of wave is shown by the red arrow while the particles are travelling in an up-down direction, shown by blue arrows. The direction of both is perpendicular. Such waves are transverse waves.

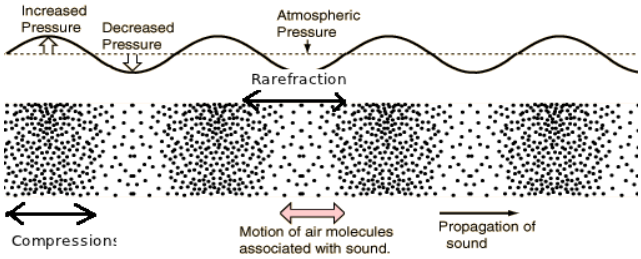


The peak of the wave is crest while the lowest point is the trough, as shown above.

Longitudinal waves:

- Longitudinal Waves are waves that travel parallel to the direction of motion.
- Examples are sound wave and pressure waves.

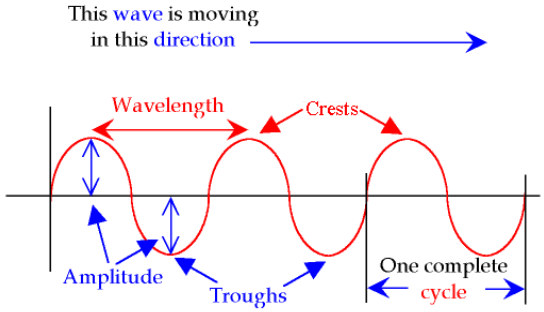
- They form compressions and rarefactions.
- Compressions are region where the air particles are close together, creating high pressure.
- Rarefactions are areas where the air particles are far apart, creating low pressure.



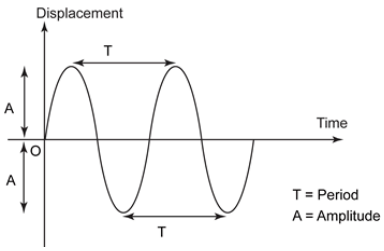
In the above diagram, we can see that the region where the air molecules are compressed together, creating increased pressure is compression. While the regions where air molecules are further apart is the region with decreased air pressure and is rarefaction of wave.

Properties of Wave Motion:

- Crests and troughs: The highest and lowest points of a transverse wave respectively. For longitudinal waves, they are the regions of compressions and rarefactions.
- Phase: Any 2 points are in phase when they move in the same direction, have the speed and displacement from rest position. (e.g. 2 crests and 2 troughs)
- Wavelength: The shortest distance between any 2 points in a wave in phase (e.g. distance between 2 successive crests). As it is the distance, its SI unit is meters (m).
- Amplitude: It is the maximum displacement from the rest position; the height of the crest/ depth of a trough from the rest position. As it is also the displacement measured, its SI unit is metres (m).



This wave clearly shows all the terms we have discussed. On complete cycle can be called one complete wave or oscillation.



The displacement-time graph can be used to show the motion of wave.

Now with this graph, more terms can be introduced. Don't worry, they aren't that tough!

- Period (T): This is the time taken for one point on the wave to complete one oscillation. Or you can say, the time taken to produce one complete wave. As it is the time being measured, the SI unit is that of time: second (s).
- Frequency (f): This is very much related to the period of wave. It is actually the number of complete waves produced per second. Its SI unit is Hertz (Hz).

We can relate frequency to the period by the following equation:

$$f = 1 / T$$

It's inversely proportional right? So this means that when f is greater, (i.e. more waves are produced in one second), then T will be shorter.

- Wave speed: It is the distance moved by the wave when it has travelled for one second.In a time of one period (T), a crest on a transverse wave would have moved a distance of one wavelength (λ). Therefore, the speed of a wave is given by:

$$v = \lambda / T$$

where v is the speed of wave, λ is the wavelength and T is the time period.

Since

$$f = 1 / T,$$

Therefore, $v = f\lambda$

- Wavefront: A imaginary line on a wave joining all points in the same phase; usually drawn by joining the wave crests.

Ripple Tank:

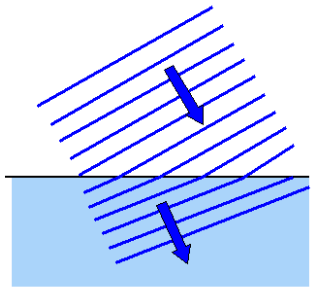
Ripple tank is basically used to generate water waves to demonstrate wave properties such as reflection and refraction.

Wave refraction: By placing a piece of plastic in the ripple tank, a region of shallow water is created.

The wavelength shortens but the frequency remains the same as it is determined by the dipper.

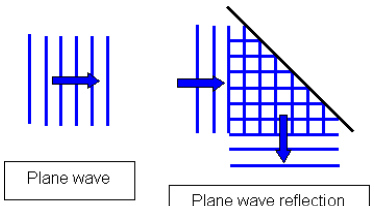
Thus by the equation we just learned, the velocity of the wave will also decrease. The diagram below will make it clear to you.

Task: Google the apparatus of ripple tank and how it works.



Plane wave refraction

Wave reflection: By placing a plastic sheet *at an angle to the incoming waves*, the waves will reflect, just like light waves. Have a look at the diagram below.



Plane wave

Plane wave reflection from a flat barrier

Note that the laws of reflection and refraction will be applied here as well.

Worksheet # 3 **Submission: 18 March 2015**

In Fig. 3.1, the length *l* of a mercury thread in a mercury thermometer is plotted against the temperature θ recorded on the thermometer.

Fig. 3.1

3 In Fig. 3.1, the length l of a mercury thread in a mercury thermometer is plotted against the temperature θ recorded on the thermometer.

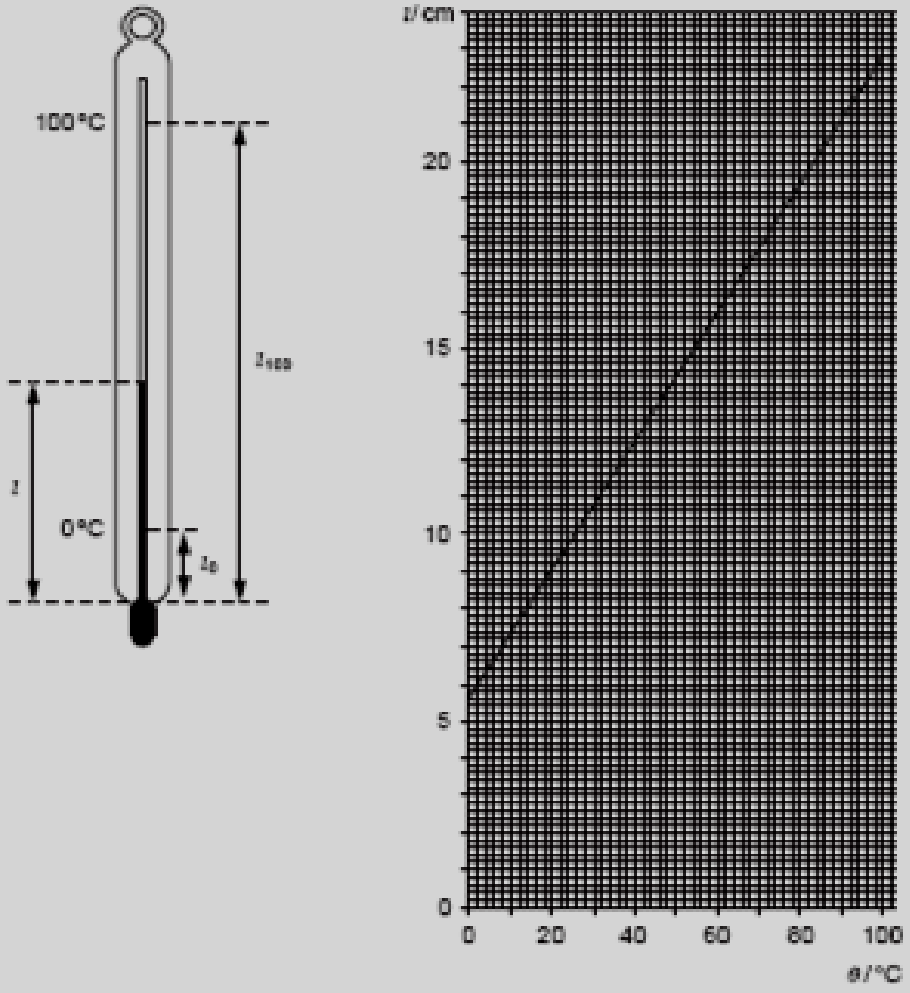


Fig. 3.1

(a) Describe how you would measure the length l of the mercury thread on a day when the laboratory temperature is 25 °C. You should use a 300 mm rule with a dead space at each end, as shown in Fig. 3.2. In your answer, state what readings you would take and how you would make your readings accurate. You may draw a diagram if you wish.

Fig. 3.2