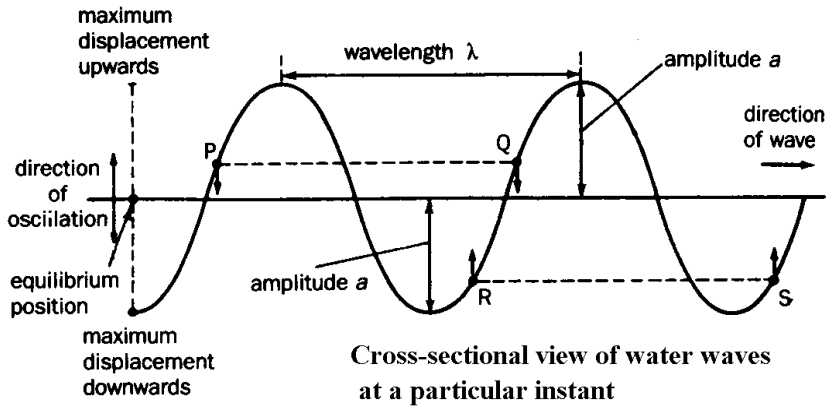
Hwa Chong Institution (High School) Name : _____ ( )
PHYSICS Notes Class : _____
Topic: General Properties of Waves Date : _____

1. Properties of wave motion



Cross-sectional view of water waves at a particular instant

a) amplitude (a)
The maximum displacement from the rest position. (SI unit : m)

b) wavelength (λ)
The shortest distance between any two points on a wave that are in phase. (SI unit : m)

c) crests and troughs
These are the high points and low points that characterise transverse waves only. For longitudinal waves, the terms compression and rarefactions are used.

d) frequency (f)
The number of complete waves that pass a point per second. (SI unit : Hertz, Hz)

e) period (T)
The time taken to produce one complete oscillation. (SI unit : s)

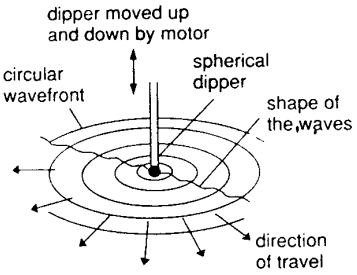
Formula relating ***f*** and ***T*** : $\mathbf{f = \frac{1}{T}}$

f) wave speed (v)
The distance travelled by a wave in one second. (SI unit : m/s)

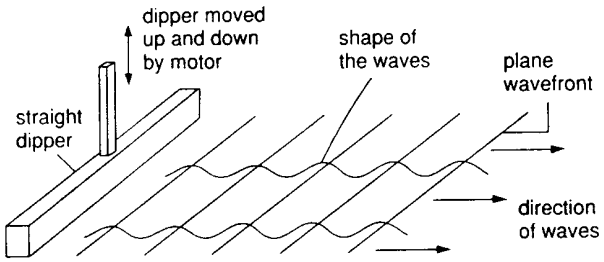
Formula relating ***v***, ***f*** and ***λ*** : $\mathbf{v = f\lambda}$

Ex-1 :
The speed, **c**, of green light of wavelength 0.6 μm in vacuum is 3.0 x 10^8 m/s. What is its frequency?

g) wavefront
An imaginary line on a wave that joins all points which have the same phase of vibration.



Circular water waves



Plane water waves

h) Phase
Two points are said to be in phase when they are moving in the same direction with the same speed and having the same displacement from the rest position, e.g. any two crests or troughs are in phase.

Note:
◊ *What is a wave*?
A wave may be thought of as a spreading of disturbance from one place to another. For example, when a pebble is dropped into a pond of still water, a few circular ripples (disturbances) move outwards on the surface of the water. As these circular ripples spread out, energy is being carried with them.

◊ *What is the source of waves*?
The source of any wave is a vibration or oscillation.

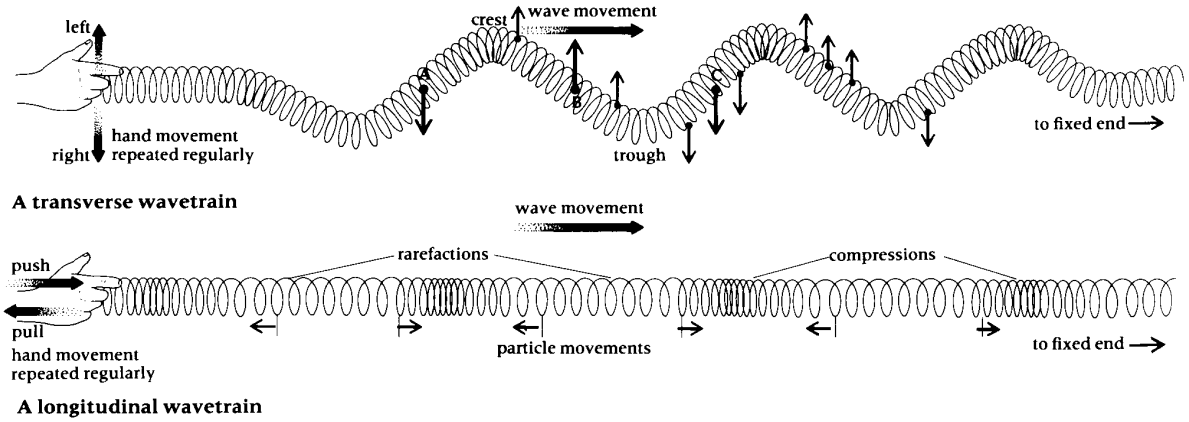
◊ Wave motion provides a mechanism for the *transfer of energy* from one point to another without the physical transfer of medium (such as rope or water) between the two points. Such a wave is known as a progressive (or travelling) wave because it is the movement of a disturbance which carries energy away from a source.

2. Types of Waves

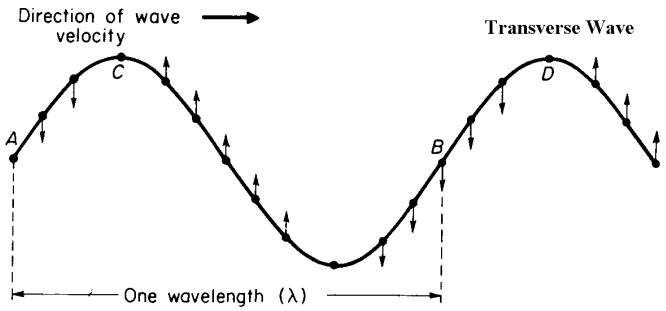
a) There are two types of waves:
- Transverse waves: are waves whose particles vibrate perpendicular to the direction of travel of the wave motion. Examples of transverse waves: water waves, light waves, rope waves.
- Longitudinal waves: are waves whose particles vibrate parallel to the direction of travel of the wave motion. Examples of longitudinal waves: sound waves.

Note:

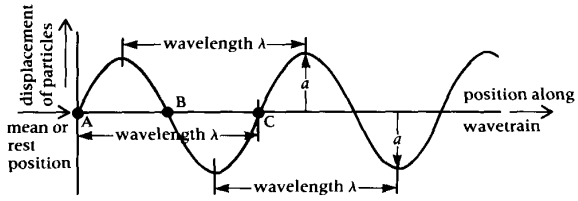
- Both the transverse wave and the longitudinal wave can be demonstrated using a slinky.



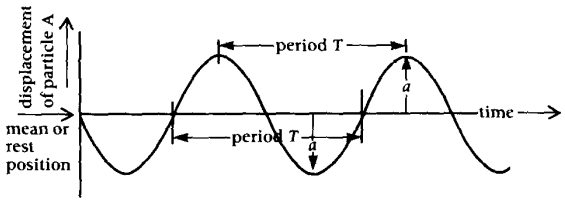
- In the diagram, note how the particles of a transverse wave behave as the wave move in a particular direction.



b) An illustration of displacement-distance graph and displacement-time graph for a *transverse wave*.



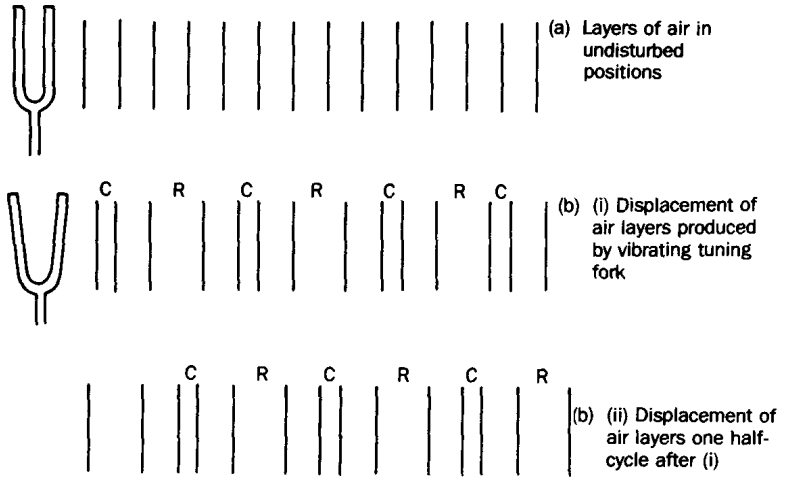
a) Displacement–position graph (at a single moment in time, like a photograph)



b) Displacement–time graph (of a single particle in the wave)

c) For *longitudinal waves*:
C***ompressions*** are regions where the air particles are closer together and the pressure increases slightly, ***rarefactions*** are regions where the air particles are further apart and the pressure decreases.

The displacement-distance graph and the displacement-time graph are drawn the same way as for the transverse waves.

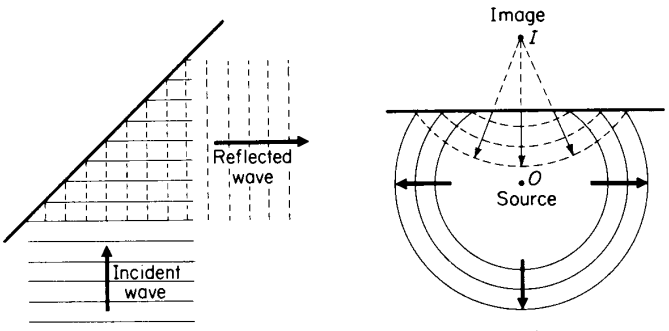


3. Wave Productions and the Ripple Tank

- Waves can be produced in ropes and slinky springs. A falling pebble produces circular water waves in a pond of still water. In the lab, water waves can be easily generated by means of a ripple tank
- The ripple tank is a useful apparatus for generating water waves, and for demonstrating wave properties (such as reflection and refraction).
- Structure of a ripple tank (refer to text for a description and a diagram)
- Plane waves can be set up by using a straight dipper made up of either wood or plastic. Circular waves can be formed by using a spherical dipper made of plastic. The dipper is attached to a motor that causes the vibration. The waves will be seen as bright and dark patches on the screen below the tray. These patches show the positions of the crests and troughs of the waves.

a) Reflection of waves

Note:
- There is no change in wavelength, speed of waves and frequency.
  Why?
  Because there is no change in depth of water and source of vibration.



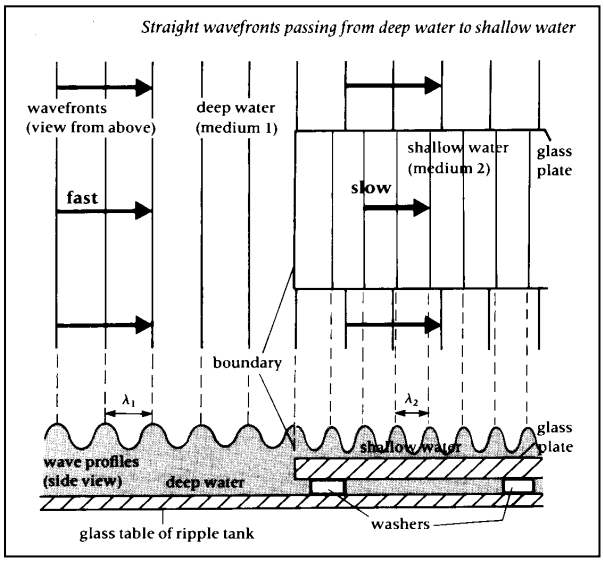
Reflection of straight and circular waves from a plane surface

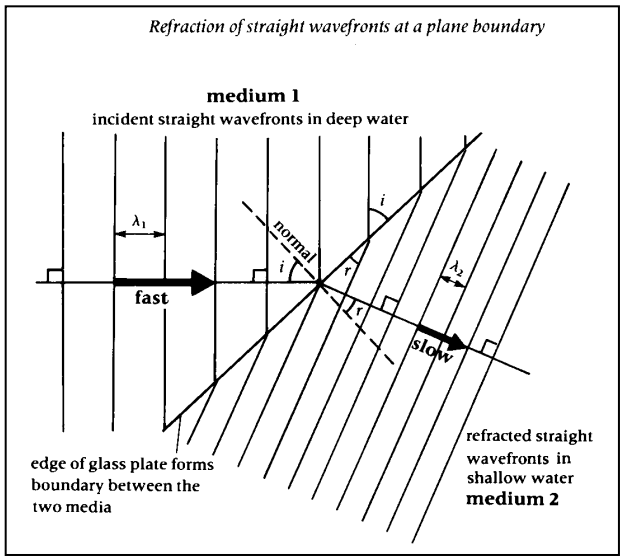
b) Refraction of waves

If a piece of glass plate is placed onto the tray so that a region of shallow water is created, the following would occur:

- the ***wavelength*** of the plane waves shorten on passing from the deep water to the shallow water;
- the ***speed*** of the waves in the shallow water is slower than that at the deeper water;
- the ***frequency*** remains unchanged as it is determined by the source.

Plane wavefronts travelling at straight-through and at oblique angle.





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