3.2 Longitudinal and transverse waves

As discussed in 3.1, progressive waves transfer energy from one place to another. This means that the direction of wave travel is the direction the energy is moved. Oscillations that facilitate this movement of energy are either parallel to this direction (longitudinal waves) or at right angles to this direction (transverse waves).

videos

It is best to observe some animations of longitudinal and transverse waves:
http://www.acs.psu.edu/drussell/Demos/waves/wavemotion.html

Sound waves and seismic-P waves are examples of longitudinal waves. They are often described as compressional waves as particles in the medium are squeezed together (compressed) and stretched apart (called rarefaction), as the wave passes.

Water waves, seismic-S waves and electromagnetic waves are examples of transverse waves. Electromagnetic waves do not require a medium in which to travel. In electromagnetic waves the oscillations are in the magnetic and electric fields which are not only at right angles to the direction of wave travel, but at right angles to each other:
http://www.walter-fendt.de/html5/phen/electromagneticwave_en.htm

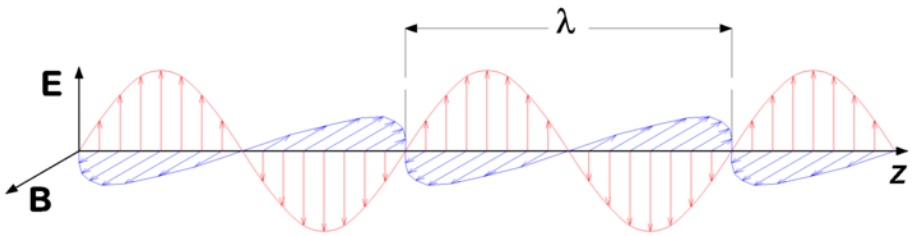
All electromagnetic waves travel at the same speed (the speed of light) in a vacuum.

(1) What is the speed of light in a vacuum?

(2) What happens to electromagnetic waves when they enter a material?

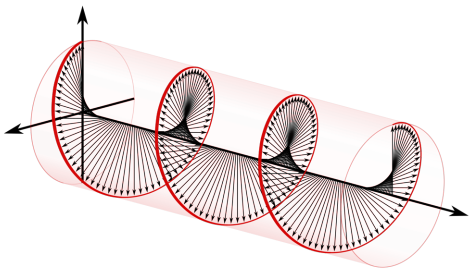
Polarisation

The following diagram shows an electromagnetic wave that is plane-polarised:



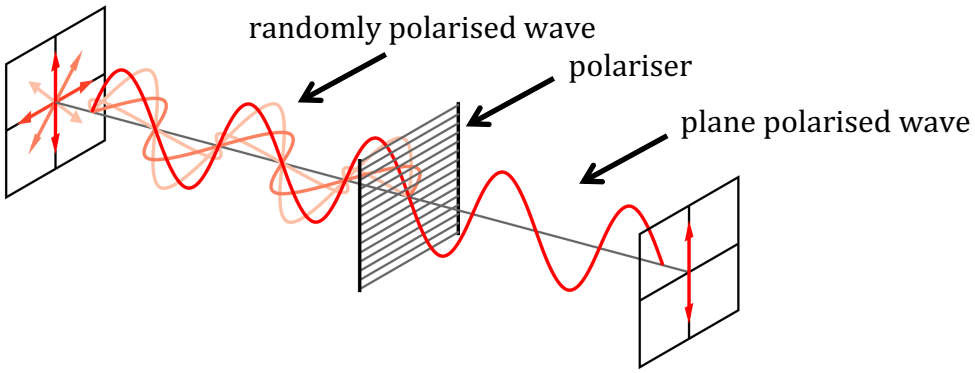
The electric field (E) is oscillating in the vertical plane and the magnetic field (B) is oscillating in the horizontal plane. Plane-polarised means that either E and B are oscillating in one plane only. Only transverse waves can be polarised.

The following diagram shows a circularly polarised wave:



In this case only the electric field orientation is shown.

In the following diagram, randomly polarised electromagnetic (EM) waves are passed through a polariser, which only lets through a certain component, producing plane-polarised light. The transmitted plane polarised wave has a lower intensity than the randomly orientated wave.



The situation above can be studied using a microwaves and a metal grille for a polarizer. When the electric field (shown in red) oscillates in the direction of the metal grille, an oscillating current is produced in the grille which stops transmission of the wave. If the grille is at right angles to the electric field, no current is produced in the grille and the waves is transmitted (as shown).

(3) ✐ When two polarisers are angled at 90° to each other, this is a situation known as 'crossed polarisers'. What do you think happens in this situation?

(4) ✐ Do some research and find 3 uses of polarisers.