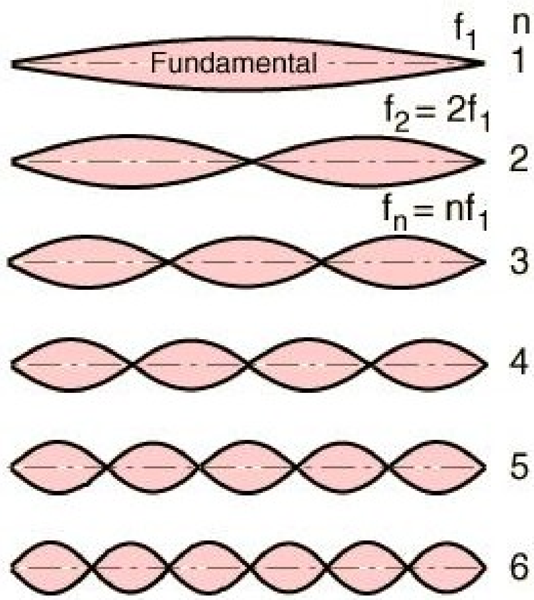
Unit 2 – Understanding Processes – Section C

Wave Superposition

Example Chosen: Standing waves used in guitar strings.

Diagram:



Fundamental: $(l = \lambda/2)$
1st Harmonic: $(2 = 2\lambda/2)$ etc. - Identify nodes and antinodes.

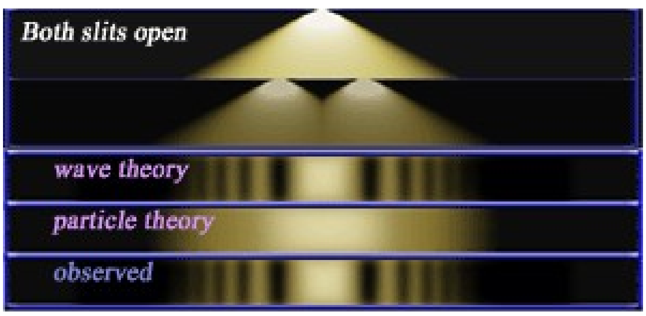
The ends of guitar strings are nodes. By changing the position of one of those nodes through fretwork, the guitarist changes the effective length of the vibrating string, and hence the note played.

By plucking the string, vibrations occur up and down the neck of the guitar. These superpose and create a standing wave. Only those with the correct frequency will not be destructively superposed, hence creating these harmonic tones which are also heard along with the fundamental frequency.

http://www.bsharp.org/physics/stuff/guitar.html

Example Chosen: Young's double slit experiment.

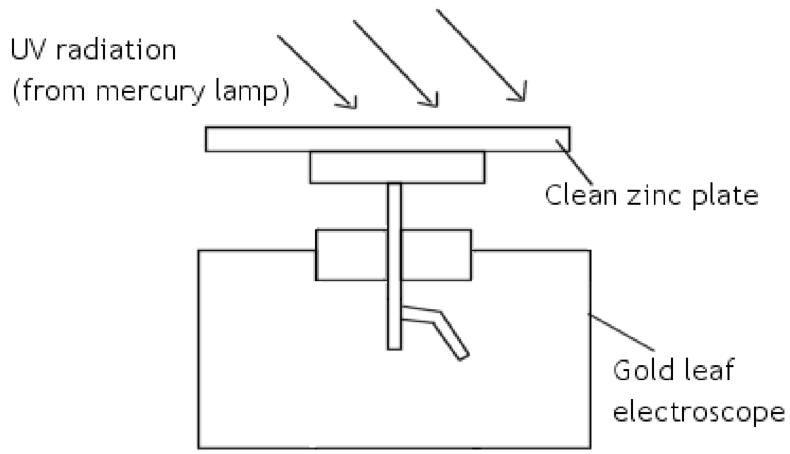
Diagram:



Quantum Behaviour

Example Chosen: The Photoelectric Effect

Diagram:



The electroscope is given an initial negative charge so the leaf rises. When the mercury lamp is off, the leaf stays in this position. However, when the lamp is switched on to allow UV radiation to fall on the zinc plate, the leaf gradually falls.

The leaf falls because the electroscope loses charge. This only happens when UV radiation falls on the zinc plate. Free electrons in the zinc plate gain sufficient energy from the UV radiation to leave the plate.

When EM radiation is directed at a metal surface, a steam of photons bombard the surface. Any free electron near the surface could be struck by a photon, absorbing the photon's energy and gaining kinetic energy. Each photoelectron from a metal plate has gained the whole amount of energy of a single photon, hence the maximum energy gained, $E = hf$.

To escape from a metal, an electron must do a certain amount of work to remove itself from the surface to *infinity.*

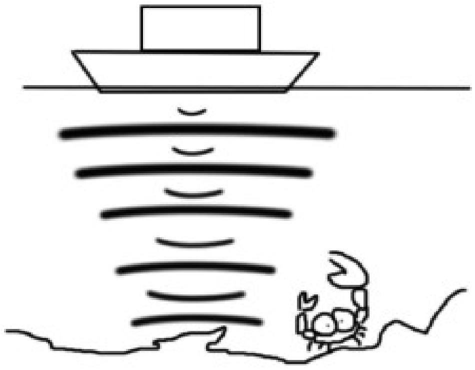
The reason the negatively charged leaf will discharge and collapse is that electrons will be liberated from it, gradually making it neutral, while liberating electrons from the positively charged leaf makes it even more positive, keeping the leaves apart.

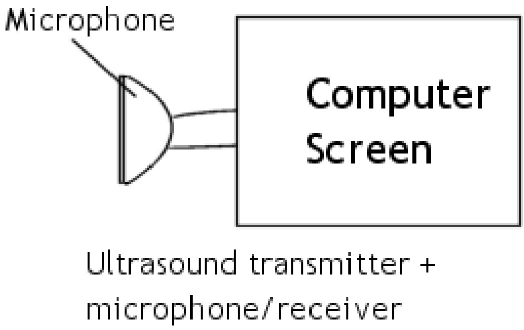
Measuring Distance

Example Chosen:

Measuring the depth of a sea bed using Sonar (ultrasound).

Diagram:





Explanation of what and how the measurements are made:

- Ultrasound transmitter emits pulses of ultrasound.
- These reflect off the sea bed and return to the ship.
- Microphone detects the time and strength of the reflected waves.
- Computer calculates time delay and therefore position and density of the reflected surface.

How is the distance calculated?

Time between distance transmitted and received pulse is measured = *t*.
Distance = speed x time.
Therefore, distance = v(t/2) – time to sea bed only.
V = 1200 ms^{-1} (speed of sound in water – depends on temperature)

Factors contributing to uncertainties in measurements:

- Temperature of water varies, hence the speed of ultrasound will vary.
- Shoals of fish etc. can also reflect the pulses of ultrasound.
- Ship will bob up and down on waves which will add a small error.

Speed of signal transmission:

~ 1200 ms^{-1} (variable)

Distance messages sent:

~ 500m

Approximate time for sending messages:

t = s/v
= 500/1200
= 5/12 s there,
Hence, 10/12 s there and back.