**U3a Physics: Atomic and Nuclear Physics**

**Session 9**

**Wave Particle Duality (cont)**

**Re-cap from last week: The de Broglie equation**

Louis de Broglie proposed that, just as light has a dual nature, so do all particles. He proposed that a particle of momentum *p* would have a wavelength *λ* given by the equation:

* wavelength of particle ***λ*  = *h/p***
* where *h* is the Planck constant, and p is the momentum of the particle
* or *λ* = *h/mv* for a particle of momentum *mv*, where m is its mass and *v* is its velocity

The formula allows us to calculate the wavelength associated with a moving particle.

(The momentum, *p*, of a moving object is equal to its mass multiplied by its velocity, so *p* = *mv*)

**Some calculations to try**

**(1) What is the wavelength of an electron?**

Assume an electron is moving at 107 m/s

It’s mass is 9.11 x 10-31 kg

*h* =  6.63×10−34Js

Using the formula *λ* = *h/mv*

*λ* = 6.63×10−34 ÷ (9.11 x 10-31 x 107)

= 7.3 x 10 -11 m

This is roughly the same as the spacing between atoms in a solid... which is why the electrons are diffracted as they pass through graphite.

**(2) Human waves?**

The de Broglie relationship applies to all matter.

So, what is the wavelength of a person of mass 66 kg, running at 10 m/s?

Using the formula *λ* = *h/mv*

*λ* = 6.63×10−34 ÷ (66 x 10)

= 1,0 x 10 -36 m (to 2 sf)

This is a (very) much smaller gap than a human could fit through.

This is why we don’t use the wave model to describe people, but get better results by regarding them as large particles.

**(3) Tennis Ball** (for anyone who would like to try another calculation!)

What is the wavelength of a tennis ball of mass 55g travelling at a speed of 35 m/s?

First, convert 55g to kg, giving *m* = 55/1000 = 0.055 kg

Using the formula *λ* = *h/mv*

*λ* = 6.63×10−34 ÷ (0.055 x 35)

= 3.4 x 10 -34 m (to 2 sf)

Again, this value of the wavelength is much smaller than any gap that the tennis ball could fit through, and so we don’t observe any wave-like properties of the ball.