Physical Science 100  
Chapter 16, Duality of Matter

- Momentum = mass × speed
- All particles have a wave nature → Wavelength = Planck’s constant / momentum
- Matter and light have a dual wave/particle nature. Matter in its finest form is observed as particles, but when unobserved is described by waves of probability

*Electrons or photons arrive as lumps. The probability of arrival is determined as the intensity of waves would be. It is in this sense that the electron behaves sometimes as a particle and sometimes like a wave.*
Limits to knowledge

- There are limits on what we can know.
- The momentum and position of a particle cannot be exactly known at the same time.
- The product of the uncertainty in position ($\Delta x$) and the uncertainty in momentum ($\Delta p$) must be greater than Planck’s constant ($h$). Mathematically, we write this: $\times (\Delta p) \geq h$

Wave packets

- The position and momentum of electrons as they travel through space is described as a “wave packet”.
- The electron is not a wave.
- There is a probability of finding the electron in a certain position in space.
- This probability behaves as a wave.
- Quantum mechanics tells us that the electron is somewhere inside the packet.
- When we make a measurement, the wave packet collapses and only one of the possibilities becomes reality.