3.3 Origins of Quantum Theory

- Black body: an ideal, perfectly black object that does not reflect any light and emits various forms of light as a result of temperature.
- Quantum: a small, discrete, indivisible quantity.

Quantum Hypothesis (1900)

- Max Plank started the quantum revolution.
- Plank explained why light intensity did not follow the classical hypothesis (increase in light energy = increase in intensity). He found that by using quanta he could explain the observed values.
- Plank thought he was wrong and did not pursue this research, it was Albert Einstein who stated that Plank's work showed black bodies emit packets of energy (quanta)
- For black bodies the classic theory does not work because as an object becomes white hot it needs to emit all wavelengths of light to produce white light. Therefore, a bell curve is created with a peak skewed towards the UV.

Photoelectric Effect

- 300 BC Greeks thought of light as a stream of particles.
- 17^{th} Century, Christian Huygens explained light as a wave but Newton described it as corpuscular (particles).
- Mid 19^{th} Century, James Maxwell proposed that light was an electro-magnetic wave.
- This was a well established fact until 1887 when Hertz discovered the photoelectric effect.
- Photoelectric effect: light hitting a metal surface causes electrons to be ejected from the surface of the metal.
- Why is it was a big deal: It was thought that if you increase the intensity of light energy the energy of the electron ejected would increase. However, this was not the case. It was found that wavelength affected the energy of the electron.
- Einstein won a Nobel Prize in 1905 for using Plank's hypothesis (Quantum Theory) to explain the photoelectric effect.

- Einstein found that light was emitted as photons (quanta of light) and depending on the wavelength they had different energy. A red photon was low energy and would likely not eject an electron. However, an UV photon is higher in energy and will cause an electron to be ejected from the metal plate (an elastic collision of particles).
- However, a minimum amount of energy is needed to eject the electron. If there is not enough energy the electron will drop back to its ground state. The addition of additional energy is not accumulative.
- Wave-Particle Duality: light behaves like a wave and a particle and both are possible in quantum theory, and the photon could be considered a wave packet.

Homework

- Practice 1,2,3,4
- Questions 1,2,3,4,5