The Ultraviolet Catastrophe

Blackbody: absorbs and emits all frequencies
Max Planck explanation:
Energies of the oscillations of electrons which gave rise to the radiation must be proportional to integral multiples of the frequency:

\[ E = nh\nu \]

\[ h = 6.626 \times 10^{-34} \text{ J.s} \]

Planck could not offer a good justification for his assumption of energy quantization.
The Photoelectric Effect

You will see an animation in the lectures
The Photoelectric Effect

1886 and 1887, Heinrich Hertz: ultraviolet light can cause electrons to be ejected from a metal surface.

According to the classical wave theory of light, the intensity of the light determines the amplitude of the wave, and so a greater light intensity should cause the electrons to be ejected with a greater kinetic energy.

Experiment showed that the kinetic energy of the ejected electrons depends on the frequency of the light. The light intensity affects only the number of ejected electrons and not their kinetic energies.
Vibrations in crystals

Classical physics: molar heat capacity at constant volume \((C_v)\) of a crystal is \(3R\)

At high temperatures \(\sqrt{\text{√}}\)
but for low temperatures \(C_v \rightarrow 0\)

Einstein:
Oscillations of atoms about their equilibrium positions are quantized

\[ E = n \hbar \nu \]
The H atom spectrum

The H atom line spectrum
The H atom spectrum

Rydberg:

\[ \nu = \frac{R_H}{h} \left( \frac{1}{n_i^2} - \frac{1}{n_o^2} \right) \]

\[ \nu = 3.289 \times 10^{15} \text{ s}^{-1} \left( \frac{1}{n_i^2} - \frac{1}{n_o^2} \right) \]
Line Spectrum

Lyman

Balmer

Paschen

Dr. Mohammad Kadi
Rutherford’s experiment

You will see a film the in the lectures