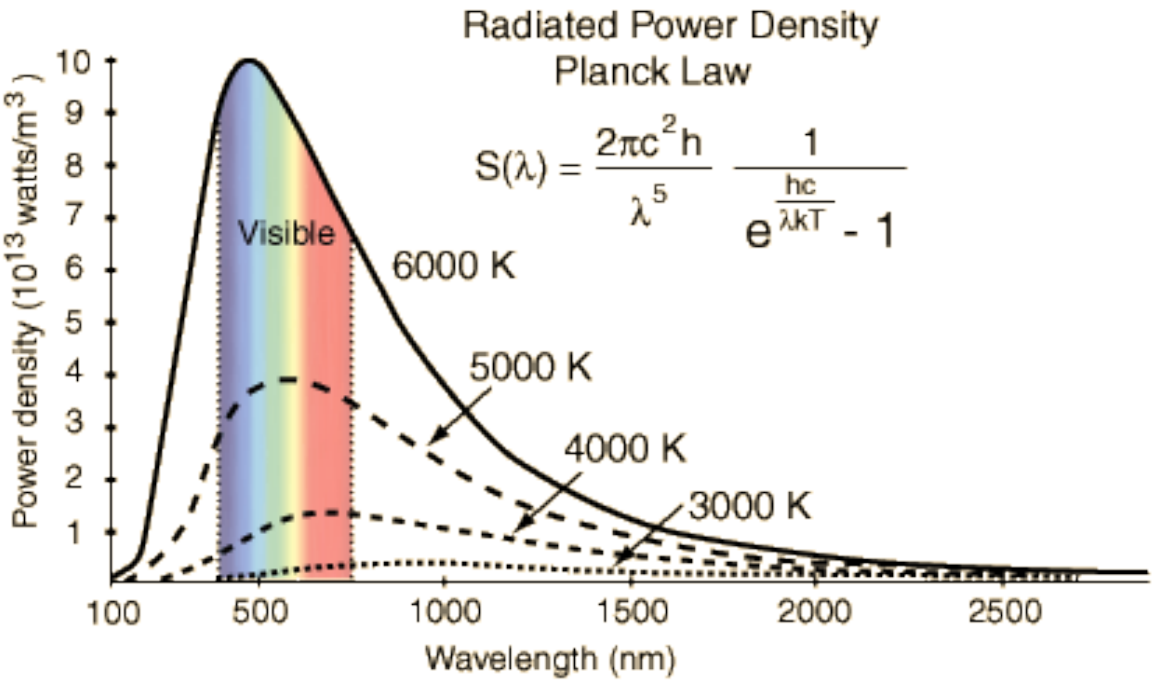
Why and when do we need quantum mechanics?

- Many observed phenomena cannot be descibed by classical physics
- QM is applicable when the action is of the order of Plank's constant
- QM is most often necessary to describe the microworld (though some macroscopic phenomena require quantum mechanics as well)

Timeline of quantum mechanics (most notable discoveries)

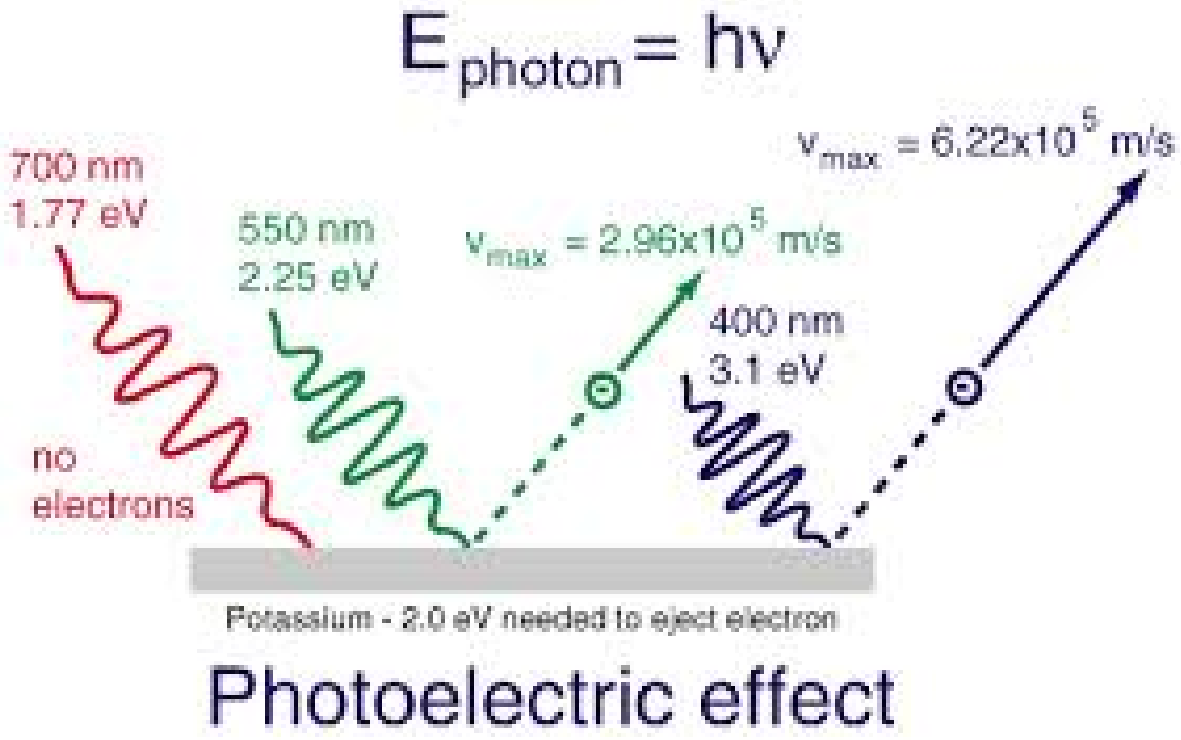
- **Max Planck (1901). Black body radiation.**
  Idea of quantized energy, or quants: $E = nh\nu$



$h = 6.62 \times 10^{34}$ J·s – Planck's constant

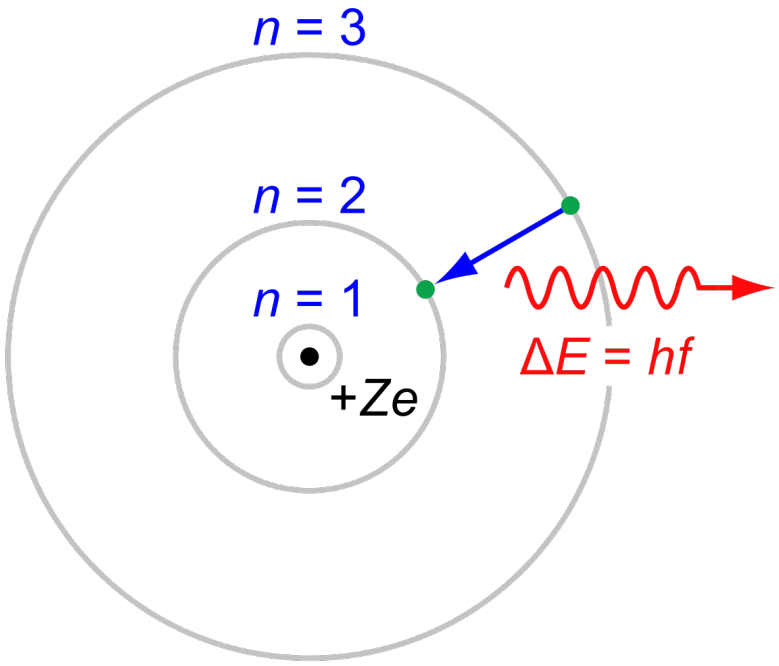
Timeline of quantum mechanics (most notable discoveries)

- **Albert Einstein (1905). Photoelectric effect.**
  $h\nu = W + \mathrm{K.E.}$



Timeline of quantum mechanics (most notable discoveries)

- **Niels Bohr (1913). Hydrogen atom model.**
  $\mu v r \equiv L = n\hbar$



  $E_n = -\frac{\mu e^4}{2\hbar^2}\frac{Z^2}{n^2}$

- **Sommerfeld (1915). Extended Bohrs model to elliptical orbits.**

Timeline of quantum mechanics (most notable discoveries)

- **Louis de Broglie (1923). Particle-wave dualism.**
  $\boxed{p = \frac{h}{\lambda},\ E = h\nu}$

  $\mathbf{p} = \hbar\mathbf{k}$
- **Werner Heisenberg (1925). Matrix mechanics. Uncertainty principle**
  $\Delta x \Delta p_x \gtrsim \hbar$
- **Erwin Schrödinger (1926). Wave mechanics. The Schrödinger equation.**
  $i\hbar\frac{\partial\psi}{\partial t} = H\psi$
- **Paul Dirac (1927). Shows equivalence of the matrix and wave mechanics.**