

Übungen zur Vorlesung
Quantenmechanik für Nanostrukturwissenschaftler und Lehrer

Exercise 1

Task 1

- a) The maximal energy of the photoelektron from aluminium is 2,3 eV at a radiation with 200 nm and 0,9 eV with 258 nm. With this, calculate the Planck constant h and the work function W_A of aluminium.
- b) Electromagnetic radiation of the wavelength $\lambda = 290$ nm hits a metal surface with the work funktion of $W_A = 4,05$ eV. Which potential difference (voltage) is necessary to stop the photoelektrons with the most energy?

Task 2

- a) How big is the De-Broglie wavelength of an electron with the energy of 6,0 eV?
- b) How many optical photons with the wavelenth of $\lambda = 450$ nm does a lightbulb with a power of 20 J/s per second emit?

Task 3

For the Compton effect, the momentum and energy conservation laws are $\mathbf{p} = \mathbf{p}' + \mathbf{P}$ and $h\nu + m_e c^2 = h\nu' + \sqrt{m_e^2 c^4 + P^2 c^2}$. Here, \mathbf{p} and \mathbf{p}' as well as ν and ν' are the momentum as well as the frequency of the photon before and after the impact with an resting electron, which is hit with the momentum \mathbf{P} . Show that $\lambda' - \lambda = \frac{h}{m_e c} (1 - \cos \theta)$, where θ is the deflection angle between \mathbf{p} and \mathbf{p}' . For the photons, use the relations $E = pc = h\nu$ and $\nu = c/\lambda$.

Task 4

A series of spectral lines in the hydrogen atom corresponds with the transition to a final state, which is characterized with the quantum number n . The wavelength of the radiation, which corresponds to the transition $\Delta n = 1$, is 657 nm. Find n .

Useful physical constants:

- Speed of light in vacuum: $c = 3 \cdot 10^8 \frac{\text{m}}{\text{s}}$
- Mass of electron : $m_e = 9,109 \cdot 10^{-31} \text{ kg}$
- Elementary charge : $e = 1,602 \cdot 10^{-19} \text{ C}$
- Plack constant : $h = 6,626 \cdot 10^{-34} \text{ Js}$
- Fine-structure constant : $\alpha = 1/137$