Problems Foundations of Quantum Physics

1. Compute energy and momentum of a photon which has a wavelength λ corresponding to :

- the temperature of the human body (λ=10 μm)
- the visible spectrum (λ=0.6 μm)
- a gamma radiation with (λ=0.001 nm)

2. At what temperature the mean thermal energy of the molecules of a monoatomic perfect gaz equals the energy of photons from problem 1 ?

3. What are the maximum velocities of photoelectrons obtained by illuminating a Pt and a Cs electrode (W_{extr}=5.29 eV and W_{extr}=1.89 eV) with radiation from:

- a Mercury lamp (λ=185 nm)
- a Calcium lamp (λ=423 nm)

4. We light up a metal with radiations having two wavelengths: nm and 245 nm. The corresponding stopping potentials are 0.65 V and 1.26 V. Knowing the electronic charge and the light velocity compute the Planck constant and the work of extraction.

5. A photon with λ=34.2 nm removes an electron from a metal. The electron enters a magnetic field with B=1.5 mT and moves on a circle with the radius r=1.2 cm. Compute the extraction work.

6. For a certain deviation angle θ the Compton deviation of a gamma photon with λ=0.01 nm is 2.4 pm. Compute θ and the energy given to recoil electrons.

7. Compute the Compton deviation $\Delta\lambda$ and the diffusion angle θ if the initial wavelength is λ=3 pm and the velocity of the recoil electron represents β=0.6 from the light velocity.

8. Show that a free electron can not emit or absorb a photon.

9. Compute for a H atom in Bohr's theory: radii, velocities and accelerations in the first two states.

10. How many times the radius of a H atom will increase if it is in the fundamental state and absorbs a photon with E= 12.09 eV ?

11. Compute the radius of the n^{th} orbit of a H atom if the transition to the state with m=2 emits a photon with λ=487 nm.

12. An excited H atom makes two transitions and arrives in the fundamental state after it emits two photons with wavelengths 1281.8 nm and 102.57 nm. Compute the energy of the initial state and its quantum number.

13. The difference between the wavelengths of the first lines in the series of Lyman and Balmer for atomic H is 534.7 nm. Assume one knows the electron mass, its charge and the velocity of light. Compute the Plank constant.

14. An electron moves on a circle with the radius r=0.5 cm and has a de Broglie wavelength of 0.15 nm. Compute the magnetic induction.

15. Compute the de Broglie wavelength for an electron, a proton and a ${}^{238}_{92}U$ atom if the kinetic energy of each particle equals 100 eV.