Universität Leipzig, Fakultät für Physik und Geowissenschaften

Exercises for Experimental Physics 4 – IPSP

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Exercise Sheet 4 (Summer Term 2013)

Date of Issue to Students: May 7^{th} 2013

Date of Submission: May 14^{th} 2013

Submission Place: Marked mailbox next to room 302 (Linnestr. 5)
Submission Time: 11:00 a.m. at the submission day noted above

Please note: Write your name and matriculation number on EACH sheet of paper.
Only submit the calculations and results for exercise 1-3, exercise 4 will be discussed during the instruction classes.

Exercises:

1. A beam of photons which have a wavelength equal to 6.00 pm is scattered by electrons initially at rest. A photon in the beam is scattered in a direction perpendicular to the direction of the incident beam. (a) What is the change in wavelength of the photon? (b) What is the kinetic energy of the electron? (4 Points)

2. (a) Calculate the energy per photon and the energy per mole of photons for radiation of wavelength (A) 200 nm (ultraviolet), (B) 150 pm (X-ray), (C) 1.00 cm (microwave).
   (b) Calculate the speed to which a stationary ^{4}He atom (mass 4.0026 u) would be accelerated if it absorbed each of the photons used in (a).

   (6 Points)

3. Max Planck was the first to determine the Boltzmann constant, k, and his constant h from experimental data on black-body radiation. Calculate values for k and h from the following data: The excitance M of a surface of 2000 K is 904.48 kW m^{-2}. At this temperature $\lambda_{max} = 1.451\,\mu$m. Hint: Obtain λ_{max} from the Planck distribution by differentiation with respect to λ. (10 Points)

4. Solar energy strikes the top of the Earth's atmosphere at a rate of 343 W m^{-2}. About 30 per cent of this energy is reflected directly back into space by the Earth or the atmosphere. The Earth-atmosphere system absorbs the remaining energy and reradiates it into space by black-body radiation. What is the average black-body temperature of the Earth? What is the wavelength of the most plentiful of the Earth's black-body radiation?