Universität Leipzig, Fakultät für Physik und Geowissenschaften

Exercises for Experimental Physics 3 – IPSP

Prof. Dr. J. Käs, Dr. M. Zink

Exercise Sheet 6 (WS 2012/13)

Date of Issue to Students: Nov. 16^{th} 2012

Date of Submission: Nov. 23^{th} 2012

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 circular loop of wire can be used to detect electromagnetic waves. Suppose the signal strength from a 100-MHz FM radio station 100 km distant is 4.0 μW/m^2, and suppose the signal is vertically polarized. What is the maximum rms voltage induced in your antenna, assuming your antenna is a 10.0-cm-radius loop? (6 Points)

2. For your backpacking excursions, you have purchased a radio capable of detecting a signal as weak as $1.00 \cdot 10^{-14}$ W/m^2. This radio has a 2000-turn coil antenna that has a radius of 1.00 cm wound on an iron core that increases the magnetic field by a factor of 200. The broadcast frequency of the radio station is 1400 kHz. (a) What is the peak magnetic field strength of an electromagnetic wave of this minimum intensity? (b) What is the peak emf that it is capable of inducing in the antenna? (c) What would be the peak emf induced in a straight 2.00-m long metal wire oriented parallel to the direction of the electric field? (7 Points)

3. Small particles are be blown out of the solar system by the radiation pressure of sunlight. Assume that each particle is spherical, has a radius r, has a density of 1.00 g/cm^3, and absorbs all the radiation in a cross-sectional area of πr^2. Assume the particles are located at some distance d from the Sun, which has a total power output of $3.83 \cdot 10^{26}$ W. (a) What is the critical value for the radius r of the particle for which the radiation force of repulsion just balances the gravitational force of attraction to the Sun? (Mass of the sun: $M_S = 1.99 \cdot 10^{30}$ kg) (7 Points)

4. An intense point source of light radiates 1.00 MW isotropically (uniformly in all directions). The source is located 1.00 m above an infinite, perfectly reflecting plane. Determine the force that the radiation pressure exerts on the plane.