Universität Leipzig, Fakultät für Physik und Geowissenschaften

Exercises for Experimental Physics 4 – IPSP

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Exercise Sheet 1 (Summer Term 2013)

Date of Issue to Students: April 9^{th} 2013

Date of Submission: April 16^{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. In quantum mechanics you often calculate probabilities. Here is something to remind you on the basic principles:
   A six-sided die has the numeral 1 painted on three sides and the numeral 2 painted on the other three sides. (a) What is the probability of a 1 coming up when the die is thrown? (b) What is the expectation value of the numeral that comes up when the die is thrown? (c) What is the expectation value of the cube of the numeral that comes up when the die is thrown? (5 Points)

2. Even before you get to know the atomic basics of the laser, you can calculate the photon density!
   The wavelength of red light emitted by a 3.00-mW helium-neon laser is 633 nm. If the diameter of the laser beam is 1.00 mm, what is the density of photons in the beam? Assume that the intensity is uniformly distributed across the beam. (7 Points)

3. In a series of observations on the displacement of rubber latex spheres of radius 0.212 μm, the mean square displacements after selected time intervals were on average as follows:

t [s]	30	60	90	120
$10^{12}\left\langle x^2 \right\rangle$ [m^2]	88.2	113.5	128	144

   Find the effective viscosity of water at the temperature of this experiment (25°C). (8 Points)

4. The interaction of atoms and molecules is described by a potential. The simplest form is the Lennard-Jones potential which is employed very often in physics for many different examples. Write down this potential. Suppose the repulsive term in the Lennard-Jones potential is replaced by an exponential function of the form $e^{-r/d}$: $V = 4\epsilon\left[Ae^{-r/d} - \left(\frac{d}{r}\right)^2\right]$
   Sketch the form of the potential energy and locate the distance at which it is a minimum. What is r_{min} for $A = d = 1$?