Universität Leipzig, Fakultät für Physik und Geowissenschaften

Exercises for Experimental Physics 4 – IPSP

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Exercise Sheet 2 (Summer Term 2013)

Date of Issue to Students: April 23^{th} 2013

Date of Submission: April 30^{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 and 2, exercise 3 will be discussed during the instruction classes.

Exercises:

1. Consider the collision between a hard-sphere molecule of radius R_1 and mass m, and an infinitely massive impenetrable sphere of radius R_2. Plot the scattering angle θ as a function of the impact parameter b by carrying out the respective calculation using simple geometrical considerations. (The impact parameter b is the initial perpendicular separation of the paths of the colliding molecules, Fig. 1). (6 Points)

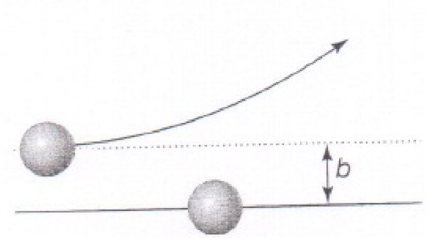

Figure 1: Definition of the impact parameter b.

2. The dependence of the scattering characteristics of atoms on the energy of the collision can be modelled as follows: We suppose that the two colliding atoms behave as impenetable spheres as in Exercise 1, but that the effective radius of the heavy atoms depends on the speed v of the light atom. Suppose its effective radius depends on v as $R_2\, e^{-v/v*}$, where $v*$ is a constant. Take $R_1 = \frac{1}{2}R_2$ for simplicity and an impact parameter $b = \frac{1}{2}R_2$, and plot the scattering angle as a function of (a) speed and, (b) kinetic energy of approach. (9 Points)

3. The *cohesive energy density* $\mathcal{U}$ is defined as U/V, where U is the mean potential energy of attraction within the sample and V its volume. Show that $\mathcal{U} = \frac{1}{2}\mathcal{N} \int V(R)\, d\tau$, where $\mathcal{N}$ is the number density of the molecules and $V(R)$ is ther attractive potential energy. The integration ranges from d to infinity and over all angles (d is the separation of particles). Go on to show that the cohesive energy density of a uniform distribution of molecules that interact by a van der Waals attraction of the form $-C_6/R^6$ is equal to $(2\pi/3)(N_A^2/d^3M^2)\rho^2C_6$, where ρ is the mass density of the solid sample and M is the molar mass of the molecules.