Universität Leipzig, Fakultät für Physik und Geowissenschaften

Exercises for Experimental Physics 2 – IPSP

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Exercise Sheet 7 (SoSe 2012)

Date of Issue: May 25^{th} 2012

Date of Submission: June 1^{st} 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. Sparks in air occur when ions in the air are accelerated to a such a high speed by an electric field that when they impact on neutral gas molecules the neutral molecules become ions. If the electric field strength is large enough, the ionized collision products are themselves accelerated and produce more ions on impact, and so forth. This avalanche of ions is what we call a spark. (a) Assume that an ion moves, on average, exactly one mean free path through the air before hitting a molecule. If the ion needs to acquire approximately 1.0 eV of kinetic energy in order to ionize a molecule, estimate the minimum strength of the electric field required at standard room pressure and temperature. Assume that the cross-sectional area of an air molecule is about 0.10 nm^2. (b) How does the strength of the electric field in (a) depend on temperature? (c) How does the strength of the electric field in (a) depend on pressure? (7 Points)

2. A 2.0 μC point charge and a 4.0 μC point charge are a distance L apart. Where should a third point charge be placed so that the electric force on that third charge is zero? (6 Points)

3. Two positive point charges $+q$ are on the y axis at $y = +a$ and $y = -a$. A bead of mass m and charge $-q$ slides without friction along a taut thread that runs along the x axis. Let x be the position of the bead. (a) Show that for $x \ll a$, the bead experiences a linear restoring force (a force that is proportional to x and directed toward the equilibrium position at $x = 0$) and therefore undergoes simple harmonic motion. (b) Find the period of the motion. (7 Points)

4. Five identical point charges, each having charge Q, are equally spaced on a semicircle of radius R as shown in Figure 1. Find the force (in terms of k, Q, and R) on a charge q located equidistant from the five other charges.

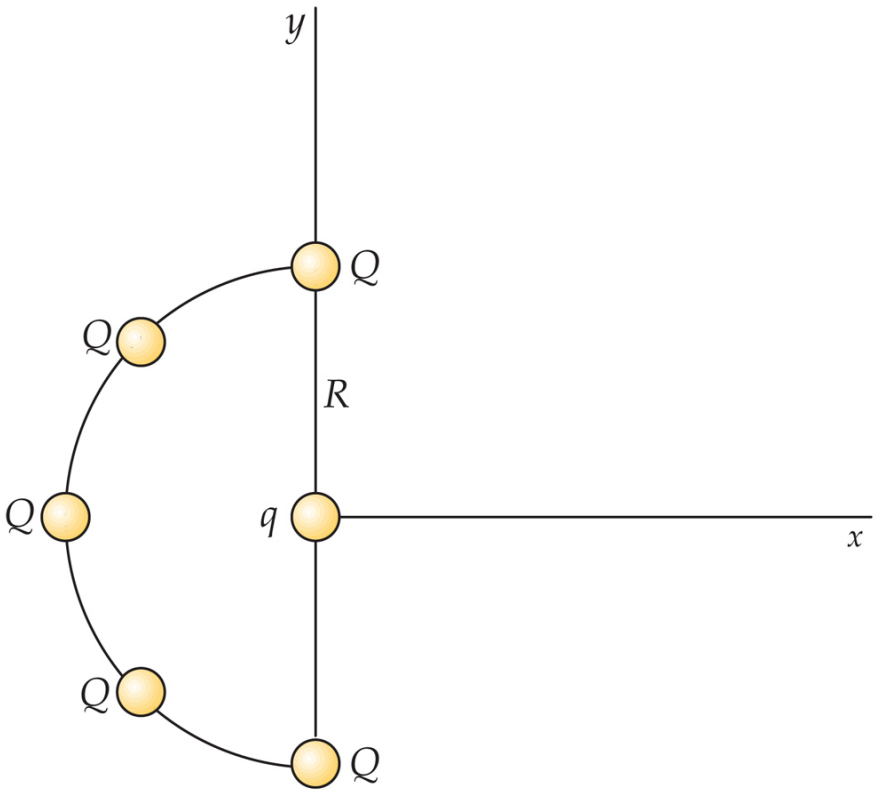

Figure 1: Exercise 4