Universität Leipzig, Fakultät für Physik und Geowissenschaften

Exercises for Experimental Physics 1 – IPSP

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Exercise Sheet 13 (WS 2011/12)

Date of Issue: Jan. 20^{th} 2012

Date of Submission: Jan. 27^{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.
Submit the calculations and results for exercise 1-3, you can also submit exercise 4 to get extra points.

Exercises:

1. An object of mass m is suspended from a vertical spring of force constant 1800 N/m. When the object is pulled down 2.50 cm from equilibrium and released from rest, the object oscillates at 5.50 Hz. (a) Find the mass m. (b) Find the amount the spring is stretched from its unstressed length when the object is in equilibrium. (c) Write expressions for the displacement x, the velocity v_x, and the acceleration a_x as functions of time t. (6 Points)

2. The bob at the end of a simple pendulum of length L is released from rest from an angle ϕ_0. (a) Model the pendulum's motion as simple harmonic motion and find its speed as it passes through $\phi = 0$ by using the small angle approximation. (b) Using the conservation of energy, find this speed exactly for any angle (not just small angles). (c) Show that your result from Part (b) agrees with the approximate answer in Part (a) when ϕ_0 is small. (7 Points)

3. A pendulum that is used in your physics laboratory experiment has a length of 75 cm and a compact bob with a mass equal to 15 g. To start the bob oscillating, you place a fan next to it that blows a horizontal stream of air on the bob. With the fan on, the bob is in equilibrium when the pendulum is displaced by an angle of 5.0° from the vertical. The speed of the air from the fan is 7.0 m/s. You turn the fan off, and allow the pendulum to oscillate. (a) Assuming that the drag force due to the air is of the form $-bv$ (b : constant, v : velocity), predict the decay time constant τ for this pendulum. (b) How long will it take for the pendulum's amplitude to reach 1.0°? Use Figure 1 (7 Points)

4. Figure 2 shows the pendulum of a clock in your grandmother's house. The uniform rod of length L = 2.00 m has a mass m = 0.800 kg. Attached to the rod is a uniform disk of mass M = 1.20 kg and radius 0.150 m. The clock is constructed to keep perfect time if the period of the pendulum is exactly 3.50 s. (a) What should the distance d be so that the period of this pendulum is 2.50 s? (b) Suppose that the pendulum clock loses 5.00 min/d. To make sure that your grandmother won't be late for her quilting parties, you decide to adjust the clock back to its proper period. How far and in what direction should you move the disk to ensure that the clock will keep perfect time? (10 Extra Points)

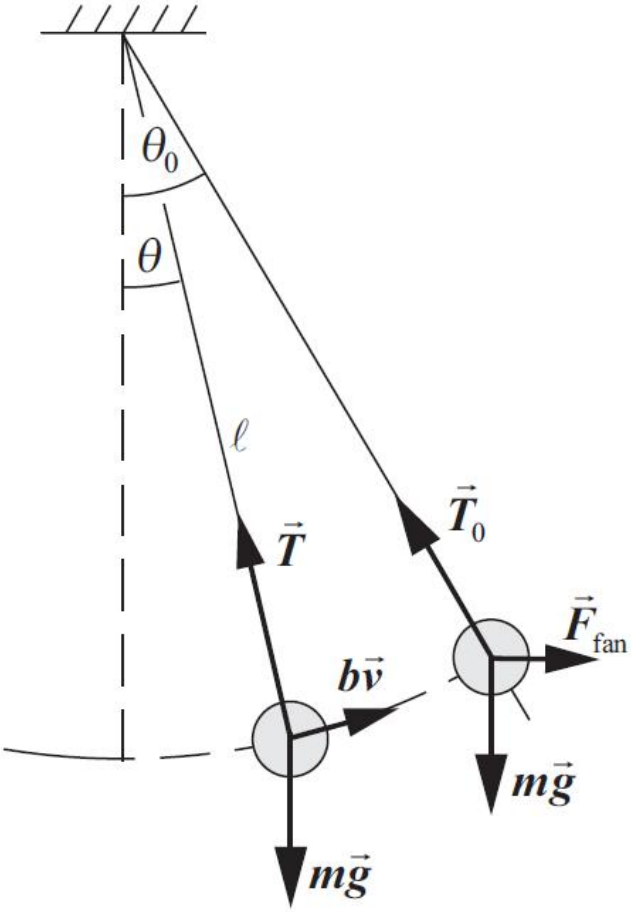

Figure 1: Exercise 3

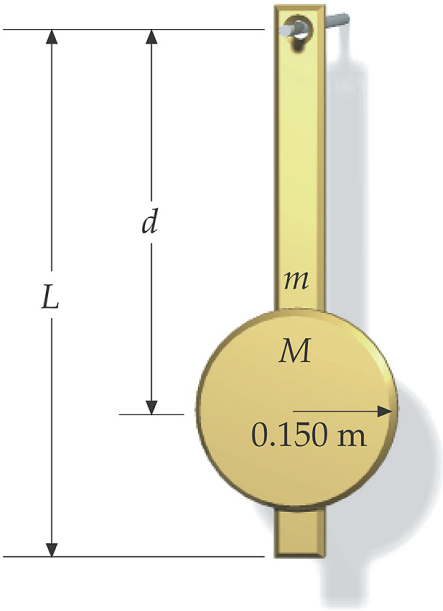

Figure 2: Exercise 4