Universität Leipzig, Fakultät für Physik und Geowissenschaften

Exercises for Experimental Physics 1 – IPSP

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Exercise Sheet 12 (WS 2013/14)

Date of Issue: Jan. 24^{th} 2014

Date of Submission: Jan. 31^{st} 2014

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.

If you need additional points to meet the criteria to participate in the exam, you can also submit exercise 4 and gain up to 10 extra points.

Exercises:

1. Working for a small gold mining company, you stumble across an abandoned mine shaft that, because of decaying wood shoring, looks too dangerous to explore in person. To measure its depth, you employ an audio oscillator of variable frequency. You determine that successive resonances are produced at frequencies of 63.58 and 89.25 Hz. Estimate the depth of the shaft. (6 Points)

2. An astronomical radio telescope consists of two antennas separated by a distance of 200 m. Both antennas are tuned to the frequency of 20 MHz. The signals from each antenna are fed into a common amplifier, but one signal first passes through a phase selector that delays its phase by a chosen amount so that the telescope can "look" in different directions (Figure 1). When the phase delay is zero, plane radio waves that are incident vertically on the antennas produce signals that add constructively at the amplifier. What should the phase delay be so that signals coming from an angle $\theta = 10^\circ$ with the vertical (in the plane formed by the vertical and the line joining the antennas) will add constructively at the amplifier? Hint: Radio waves travel at $3.00 \cdot 10^8$ m/s. (6 Points)

3. During an experiment studying the speed of sound in air using an audio oscillator and a tube open at one end and stopped at the other, a particular resonant frequency is found to have nodes roughly 6.94 cm apart. The oscillator's frequency is increased, and the next resonant frequency found has nodes 5.40 cm apart. (a) What are the two resonant frequencies? (b) What is the fundamental frequency? (c) Which harmonics are these two modes? The speed of sound is 343 m/s. (8 Points)

4. A harmonic pressure wave produced by a distant source is traveling through your vicinity, and the wave fronts that travel through your vicinity are vertical planes. Let the $+x$ direction be to the east and the $+y$ direction be toward the north. The wave function for the wave is $p(x, y, t) = A\cos(k_x x + k_y y - \omega t)$. Show that the direction in which the wave is traveling makes an angle $\theta = \tan^{-1}(k_y/k_x)$ with the $+x$ direction and that the wave speed v is given by $v = \frac{\omega}{\sqrt{k_x^2+k_y^2}}$. (10 Extra Points)

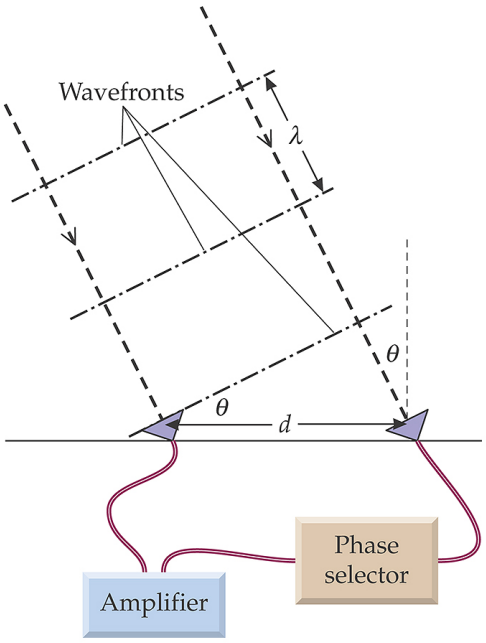

Figure 1: Exercise 2