Exercises and Complements for the Introduction to Physics II

for Students

## of Biology, Pharmacy and Geoscience

Sheet 9 / 27.04.2022   Discussion: **03.05.2022 / 04.05.2022**

Exercise 33.

In order to determine the lattice spacing of a NaCl crystal, it is irradiated with Röntgen-light of wavelength $\lambda = 7 \cdot 10^{-11}$ m. The spectrum shown in the figure is obtained by measuring the reflected radiation.

Determine the lattice spacing of the NaCl crystal from the position of the maxima.
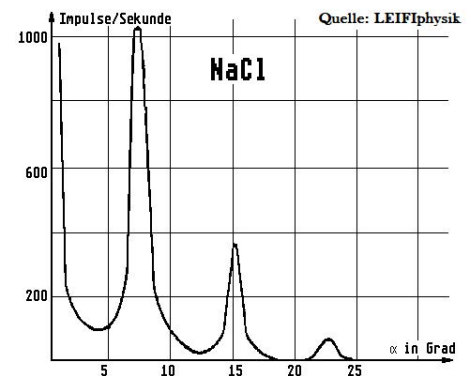
Exercise 34.

A microscope is an optical tool used for the magnification of small objects such as a cell. Our microscope has an objective of focal length $f_2 = 1.2$ cm and an eyepiece of focal length $f_1 = 2.0$ cm, which can be separated by a maximum of 20 cm. The clear viewing distance of the observer is $s_0 = 0.25$ m.

(a) How large is the theoretical magnification?

(b) What focal length would the eyepiece need to have in order to obtain a $100\times$ magnification?

(c) We would like to observe the sting of a honey bee with a microscope. The sting has a length of 2.5 mm. What focal length must the objective have such that the bee sting is magnified to a length of 18.75 mm?

Hint: The distance a between the lenses is $a = s + f_1 + f_2$, where s is the tube length.

Exercise 35.

White light is shone onto a grating with 1000 transparent slits per cm.

(a) At which angle does the 1st order maximum of red light ($\lambda = 650$ nm) appear?

(b) What is the maximum diffraction order of red light that can be produced with this arrangement?

(c) Using the above grating, find the 1st order maxima of two other lines at angles of $2.46°$ and $3.15°$. What are their wavelengths?

Exercise 36.

The labelling of a double slit for optical experiments is no longer recognizable. Therefore, the slit distance a is to be determined experimentally with a laser ($\lambda = 633$ nm). The distance d between the screen and double slit is 1700 mm. A distance of 26 mm can be measured between the 4th order maxima.

Sketch the experimental setup and calculate the slit distance a using the small angle approximation ($\sin \alpha = \tan \alpha$).

Answers:

Exercise 33. $2.7 \cdot 10^{-10}$ m

Exercise 34. (a) 175   (b) 3.2 cm   (c) 11.3 cm

Exercise 35. (a) $3.73°$ (b) 15   (c) 429.2 nm und 549.5 nm

Exercise 36. 331.1 μm