

Homework for Unit 4:
Wave Phenomena / Matter and Radiation / Diagnostics Tools

Problem 11: Refraction and reflection

A light ray impinges onto an interface between air (light speed $c_{\text{air}} = 2.997 \cdot 10^8 \text{ m/s}$) and water (light speed $c_{\text{water}} = 2.248 \cdot 10^8 \text{ m/s}$). The incident angle is 30° .

- Calculate the reflection and refraction angles for the transition air → water.
- Calculate the reflection and refraction angles for the transition water → air.
- In which situation can we have total reflection (i.e. a refraction angle of 90°)? At which incident angle does it occur?

Problem 12: beta-decay of nuclei with even and odd nucleon number

Consider the asymmetry and pairing terms of the liquid drop model for the binding energy of atomic nuclei.

- Plot the sum of these energies separately for isobars with even and odd number of nucleons A as a function of the asymmetry $N - Z$ ($A = Z + N$, Z: proton number, N: neutron number).
- Consider beta-decay towards the most stable configuration. Explain why for odd A there can be only one stable isobar, whereas for even A several stable isobars are possible, depending on the size of the pairing energy.

Problem 13: Intracranial vs. scalp EEG

Read the short article by H. Zaveri et al., Clin. Neurophysiol. 120 (2009) and answer the following questions:

- a) Electrical fields and potentials are measurable at large distance from the sources and different sources may interfere. Summarize the position of the authors, why only nearby neuronal sources need to be considered in *intracranial* EEG.
- b) The authors argue with the example of the electrical field of a point charge. Is this realistic for neuronal sources? What supports the authors' argument even in more general settings?
- c) Which term do the authors use to characterize the perceptive field of intracranial EEG electrodes? Discuss the implication for placement of these electrodes?
- d) In *scalp* EEG the sensors are several centimeters separated from the neuronal sources. What is the implication for the cortex areas influencing scalp EEG signals?