Competition in biophysics/medical biophysics 2011.

1. How high is the voltage connected to the X-ray tube if the wavelength of the produced X-ray photons of highest energy is 10 pm? How high is the anode current if $5 \cdot 10^{15}$ electrons arrive to the anode in one minute? Calculate the emitted power of Bremsstrahlung if the anode is tungsten (Z = 74). (25 points)

2. Today morning at 8 a.m. when the ^{24}Na preparation that just arrived was put into the isotope safe, the dose rate measured on the outer surface of the safe was 3 times the permitted dose rate, that is why a lead wall of 2.5 cm thickness was put in front of the safe.
a) What percent of radiation is absorbed by the lead wall?
b) After how long time the lead wall can be removed, that is after how long time will the dose rate on the outer surface of the safe decrease to the permitted value? (25 points)

3. The position of a piece of aluminum within the eye is examined by ultrasound of 20 MHz frequency and 10 mW/cm^2 intensity. The average velocity of ultrasound in the human eye is 1.6 km/s. The ultrasound reflected from the aluminum body arrives back to the transducer after 12.5 μs. What is the distance between the aluminum body and the transducer? The average decrease of intensity of ultrasound in the eye is 12 dB/cm at the given frequency, so the intensity of ultrasound arriving to the detector is 26 $\mu W/cm^2$. What is the reflexivity of ultrasound on the boundary of aluminum and eye? (30 points)

4. Describe the changes in the X-ray spectrum when the accelerating voltage is changed and when the anode current is changed. Consider both the Bremsstrahlung and characteristic radiation. Describe the changes when filter is applied. (make drawing where it is possible) (30 points)

5. Give <u>short</u> definitions for the following terms (give the unit, where it is possible) 6x5 points)

- Accommodation power
- Optical density
- Equivalent dose
- Audiogram
- Chemical potential
- Receptor potential

6. Describe the following phenomena.or principles (5x8 points)

- Beer's law
- Total reflection of light
- Pulse amplitude spectrum
- Fick's I. law
- Space constant of membrane

7.**Medicine and pharmacy:** Describe, how the resting membrane potential is formed as a result of transmembrane transport processes. (20 points)
Dentistry: Methods for examination of moving structures by ultrasound (20 points)