

## Practice questions on the semifinal exam 2019/20 I. semester (EM)

### 1. Microscopy I.

*Theoretical background:*

- types of optical lenses, parameters of them
- image formation of convex lenses
- lens laws
- image formation and magnification of microscope
- resolving power of microscope (Abbe's principle)

*Quantities to be determined based on the given data:*

calibration value of eyepiece scale and size of the object.

### 2. Refractometry

*Theoretical background:*

- law of light refraction, definition of index of refraction
- critical angle, total reflection
- formation of Snell circle
- factors influencing the value of index of refraction
- parts and function of Abbe-refractometer

*Quantities to be determined based on the given data after proper graphical representation:*  
the unknown concentrations.

### 3. Light absorption

*Theoretical background:*

- derivation of Lambert-Beer law from the absorption law
- absorbance, transmittance and the relation of them
- absorption spectrum and the information available from it
- parts of absorption spectrometer
- application of absorbance measurement in laboratory diagnostics

*Quantities to be determined based on the given data after proper graphical representation:*  
photon energy belonging to electron transition (in eV units)

### 4. Polarimetry

*Theoretical background:*

- linearly polarized, circularly polarized light and the connection between them
- definition and interpretation of optical activity
- Biot-law, specific rotation
- parts and function of polarimeter

*Quantities to be determined based on the given data:*

the type of given sugar and the unknown concentration.

### 5. Optics of the eye

*Theoretical background:*

- refractive media and image formation of the eye
- accommodation
- refractive disorders of eye and the way for correction of them
- limiting angle of vision, visual acuity (visus), factors influencing the visual acuity
- distribution of photoreceptors on the retina

*Quantities to be determined based on the given data:*

accommodation power and visual acuity.

## 6. Nuclear medicine

*Theoretical background:*

- parts of scintillation counter
- possible processes happening in the scintillation crystal
- processes happening in the photomultiplier
- signal selection, function of the discriminator, sources of noise pulses
- optimal setting of scintillation counter

*Quantities to be determined based on the given data after proper graphical representation:*  
the optimal discrimination level.

## 7. Gamma-absorption

*Theoretical background:*

- attenuation law of radiation, attenuation coefficient, mass attenuation coefficient
- processes of attenuation on the atomic scale (photoeffect, Compton-scattering, pair production, elastic scattering)
- the dependence of mass attenuation coefficients due to different processes on the photon energy
- viewpoints of radiation protection

*Quantities to be determined based on the given data after proper graphical representation:*  
 $D$ ,  $\mu$ ,  $\mu_m$ , for all the absorbents and  $\varepsilon$ ,  $\tau_{\text{mPb}}$ ,  $\sigma_{\text{mPb}}$ .

## 8. Resonance

*Theoretical background:*

- elastic deformation, Hooke's law
- harmonic oscillation
- undamped and damped free oscillation
- driven oscillation, resonance
- effect of external force (depending on the distance) on the driven oscillation (working principle of AFM)

*Quantities to be determined based on the given data after proper graphical representation:*  
the spring constant.

## 9. Skin impedance

*Theoretical background:*

- definition and components of impedance
- electric model of the skin and the possible simplifications on the model
- frequency dependence of capacitive reactance, approximation of skin impedance in case of low and high frequencies
- practical applications of impedance measurement

*Quantities to be determined based on the given data:*  
specific resistance and specific capacity of the skin.

## 10. Dosimetry

*Theoretical background:*

- the most important basic concepts in dosimetry
- function of thermoluminescent dosimeter
- application of the ionization chamber as dose rate measuring device

*Quantities to be determined based on the given data after proper graphical representation:*  
Voltage – current diagram of the ionization chamber. Name the ranges of the diagram and determine the exposure rate and absorbed dose rate in air.

## 11. Amplifier

*Theoretical background:*

- gain, gain level

- frequency response curve of the amplifier
- negative feedback
- advantages and disadvantages of feedback

*Quantities to be determined based on the given data after proper graphical representation:*

The maximum gain level, cut-off frequencies of the transfer band. Can it be used for the amplification of ECG signal?