

Competition in biophysics/medical biophysics 2016.

1. Some results of a measurement obtained by a hematological automatic equipment about a patient are the following:

WBC (white blood cell concentration): $7.5 \times 10^3 / \mu\text{l}$

HCT (hematocrit value): 33 %

MCV (mean red blood cell volume): 91 fl

MCH (the average amount of hemoglobin in one red blood cell): 33 pg

Give

a) the red blood cell concentration (in $1/\mu\text{l}$ unit)

b) the hemoglobin concentration of blood (in g/dl unit) based on the given data.

(Hematocrit value gives the total volume of blood cells related to whole blood volume. The volume of other blood cells is negligible compared to the volume of red blood cells.)

(25 points)

2. **EM and EP:** The position of a piece of Al fallen by accident in the eye of the patient is determined by ultrasound measurement. The frequency of the applied ultrasound is 20 MHz and its intensity is $10 \text{ mW}/\text{cm}^2$. The average velocity of ultrasound in the human eye is 1.6 km/s. The reflected ultrasound arrives back to the transducer after $12.5 \mu\text{s}$. What is the distance of Al piece from the transducer? The intensity of ultrasound decreases by 12 dB on 1 cm distance at the given frequency. The intensity of ultrasound arriving back to the detector is $26 \mu\text{W}/\text{cm}^2$. What is the reflectivity on the boundary of Al? (25 points)

ED: In a small university town the number of persons and the water level of the river in the town changed according to the data given in the following table.

month	no. of persons	water level (cm)
January	24600	210
April	28700	450
July	16700	120
October	27900	300

Somebody fitted the following straight line to the data:

Water level = $0.0178 \text{ cm/person} \times \text{no. of persons} - 189.75 \text{ cm}$. The correlation coefficient is $r = 0.95889$. Is there any significant correlation between the number of persons and the water level? Is there any causality between them? (25 points)

3. We need $250 \text{ MBq } ^{99\text{m}}\text{Tc}$ labeled SestaMIBI compound for an isotope test. The compound is in 100 ml solution with $15 \text{ MBq}/\text{cm}^3$ specific activity.
- a) Is this amount enough if we want to do the test after 10 hours?
- b) If it is enough, how large volume should be used for the test?
- c) If it is not enough, what should be the specific activity of the solution to be able to do the test? (30 points)
4. The average velocity of blood flow in the aorta in a resting man is 19 cm/s. The radius of the aorta is 1.2 cm. At rest the number of opened capillaries is about 1.2×10^9 . They have on average 0.7 mm length and 3 μm radius.
- a) What is the blood flow velocity in the capillaries?
- b) What time does a red blood cell spend in a capillary on average? (20 points)

5. Give short definitions for the following terms (give the unit, where it is possible) 6x5 points)
 - Mean lifetime of an isotope
 - Deterministic radiation effect
 - Specific rotation
 - Permeability
 - Resting potential
 - Critical angle of incidence
6. Describe the parts and function of gamma camera. What types of examinations can be done with it? (20 points)
7. Types of light emission spectra. Devices for qualitative and quantitative measurement of light emission. (25 points)
8. Resting membrane potential and the models for description of it. (25 points)

Angol verseny 2014/2015 megoldások és pontozás

1. a) Egy vvt 91 fl, egy μl -ben N db van, ennek térfogata (a hematokrit érték alapján) 0,33 μl .
Ebből $N = 0,33 \mu\text{l} / 91 \text{ fl} = 3,63 \cdot 10^6$, azaz a vvt koncentráció $3,63 \cdot 10^6 / \mu\text{l}$. 10 pont
- b) Egy vvt-ben 33 pg, $3,63 \cdot 10^6$ db vvt-ben $1,2 \cdot 10^{-4}$ g. Ez 1 μl vértérfogatban van, tehát a koncentráció $120 \mu\text{g}/\mu\text{l} = 120 \text{ g/l}$, azaz 12 g/dl.
2. a) 1 cm 10 pont
- b) A detektorba visszajutó UH intenzitás 25,85 dB-lel csökken. Ebből 24 dB az elnyelés miatt, tehát 1,85 dB a reflexió miatti csökkenés. Így $R = 10^{-0,185} = 0,6531$.
Vagy: 12 dB = 4·3 dB, vagyis az 1 cm 4 felezőrétegnek felel meg. A $10 \text{ mW}/\text{cm}^2$ az idegentestig $10/16 \text{ mW}/\text{cm}^2$ -re gyengül, míg a $26 \mu\text{W}/\text{cm}^2$ egy $16 \cdot 26 \mu\text{W}/\text{cm}^2$ intenzitás gyengülésének az eredménye. Így $R = (16 \cdot 26 \mu\text{W}/\text{cm}^2) / (10/16 \text{ mW}/\text{cm}^2) = 0,6656$. 15 pont
2. ED $t = 4,778$ 10 pont
 $p = 0,041$ szignifikáns, 8 pont
de nincs ok-okozati összefüggés. 7 pont
3. $A_0 = 100 \text{ ml} \cdot 15 \text{ MBq}/\text{ml} = 1500 \text{ MBq}$ 5 pont
10 óra múlva: $A = 474,3 \text{ MBq}$ tehát elegendő 15 pont
 $V = 250/474,3 \cdot 100 \text{ ml} = 52,7 \text{ ml}$ 10 pont
- 4.. a) A nyitott kapillárisok összkérszmettszete 3400 cm^2 , az aortáé $4,5 \text{ cm}^2$. A kontinuitási egyenlet alapján a sebesség a kapillárisokban $0,25 \text{ mm}/\text{s}$. 10 pont
b) $t = l/v = 2,8 \text{ s}$. 10 pont.

Általános javítási elvek: számolási hiba: 20 % levonás,
mértékegység hiba vagy hiány: 25 % levonás,
átváltási hiba darabonként 25 % levonás,
elvi hiba: 50 % levonás.

A kijavított feladatokat kérem május 9-én délig.

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