Competition in biophysics/medical biophysics 2014.

1. The temperature of the walls of a building reaches 45 °C on a summer day.
    a) How much heat is irradiated in one hour by a person of 1.2 m^2 surface area, 84 kg mass and 30 °C surface temperature?
    b) How much heat is taken up in one hour by this person from the energy radiated by the environment?
    c) How large would be the temperature increase during one hour if the heat exchange could happen only by radiation? (30 points)

2. The number of possible microstates in a thermodynamic system is $10^{3,15 \cdot 10^{23}}$ under standard circumstances. The system gets in isothermal reversible way to a macrostate that can be realized by $10^{2,83 \cdot 10^{23}}$ microstates.
    a) Calculate the entropy change.
    b) How much heat is given to the system? (25 points)

3. There are standing waves formed in a quartz crystal used for ultrasound production. The half wavelength of the standing wave equals to the thickness of the crystal. The velocity of ultrasound in the crystal is 5390 m/s, while in the soft tissues it is 1540 m/s.
    a) How thick is the crystal producing ultrasound with 7.5 MHz frequency?
    b) What is the frequency and wavelength of this ultrasound in soft tissues?
        (20 points)

4. The following table was found in a tentative protocol :

ID setting (baseline)	Pulse number without isotope	Pulse number with isotope
500	36, 42, 39	658, 623, 702
***	69, 73, 62	985, 960, 1007

(The figures signed by *** are unfortunately unreadable)
a) Is the ID setting signed by *** higher or lower than 500? Justify your answer.
Which is the better (more optimal) setting from the two? Justify your answer. (All the other parameters of the scintillation counter remained the same.) (25 points)

5. Give <u>short</u> definitions for the following terms (give the unit, where it is possible) 6x5 points)
    - Transmittance
    - Resonance curve
    - Multichannel analyzer
    - Loudness level
    - Integral (mean) vector
    - Time constant of membrane

6. Describe the following phenomena or principles (5x8 points)
    - Snell's law
    - Abbe's principle, Abbe's formula and its interpretation
    - Zeroth law of thermodynamics
    - Direct and inverse piezoelectric effect, practical application of them
    - Fourier theorem

7. **EM and EP:** Characteristics of linearly and circularly polarized light; connection of them; optical activity, Biot law, Parts of polarimeter, half-shadow device. (30 points)
   ED: One-sample and two-samples t-test. (Steps of the tests, comparison of them.) (30 points)

Angol verseny 2013/2014 megoldások és pontozás

1. E_{le} = 2,075 MJ   8 pont
        E_{fel} = 2,518 MJ   8 pont
        ΔE = 443 kJ   4 pont
        $\Delta\theta = \Delta E/(m\cdot c)$ = 1,5°C   10 pont

2.

        $S = k\cdot\ln w$
        $S_1 = k\cdot 3,15\cdot 10^{23}\cdot\ln 10$ = 10 J/K
        $S_2 = k\cdot 2,83\cdot 10^{23}\cdot\ln 10$ = 9 J/K
        ΔS = -1 J/K változás vagy az entrópia 1 J/K-el csökkent   18 pont
        (Negatív előjel vagy csökkenésre utalás hiánya miatt 5 pontot vonjunk le.)

        $\Delta S = \Delta Q_{rev}/T$
        ΔQ_{rev} = -298 J   7 pont

3.   a) $d = \lambda/2$ = 0,36 mm   8 pont
        b) f = 7,5 MHz   5 pont
        $\lambda_{szövet}$ = 0,2 mm   7 pont

4.   Jel/zaj az 500-as baseline-nál: 15,95   5 pont
                jel/zaj az ismeretlen baseline-nál: 13,47   5 pont
                 Az 500-ashoz tartozik a nagyobb ID szint, mert kevesebb az impulzus   5 pont
                Az 500-as a jobb, mert itt nagyobb a jel/zaj arány   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 kedvezmény feltétele : összesen legalább 100 pont elérése.

A kedvezményt elértek dolgozatát kérem **május 12-én 12 óráig**. (Ha valaki kedvezményt kap, a versenydolgozat tekintendő a vizsga írásbeli részének, tehát meg kell őrizni.) Akkor is kérek visszajelzést, ha a csoportból senki nem kap kedvezményt. **Kérem, hogy az egyeztetés előtt senki ne mondjon semmit a hallgatóinak az elért versenykedvezményről!**

                                Voszka István