

**April 14, 2011**

## **ANSWER SHEET - Problem 2**

**Lenses, not only contact ones**

**Country: \_\_\_\_\_**

**Team: \_\_\_\_\_**

<b>Student's name</b>	<b>Signature</b>

## A. Optical properties of various lenses **40 pts**

### TASK A.I: THICK WATER LENS WITH VARYING RADIUS

Add your cardboards with the rays to the Answer sheet. **2 pts**

A.I.1 Fill the following table				3 pts
$R$ (cm)				
$f$ (cm)				

Do not forget to add GRAPH1 to the answer sheet **3 pts**

A.I.2 What is the pattern of your graph? Choose one of the following possibilities.	2 pts.
<p>a) <math>f = ke^{qR}, q &gt; 0</math></p> <p>b) <math>f = ke^{qR}, q &lt; 0</math></p> <p>c) <math>f = kR + q, k &gt; 0</math></p> <p>d) <math>f = kR + q, k &lt; 0</math></p> <p>e) <math>f = kR^2 + qR</math></p>	

A.I.3 Estimate the values of the parameters $k$ and $q$ from your graph including the correct units.	3 pts
<p><math>k =</math></p> <p><math>q =</math></p>	

A.I.4 Determine the refractive index of waterglass.	4 pts
<p>Formula for <math>n</math>:</p> <p><math>n =</math></p>	

**TASK A.II: OPTICAL BENCH**

**A.II.1 Use the Fig 6 to derive the formula for the magnification in terms of the distance of the light source to the lens  $a$  and the distance of the image to the lens  $a'$ . 3 pts**

$Z =$

**A.II.2 Fill the following table. 8 pts.**

No.	$a$ (cm)	$a'$ (cm)	$Z$
1			
2			
3			
4			
5			

**Do not forget to add the GRAPH A2 to the Answer sheet.**

**4 pts**

**A.II.3 Derive the formula for the magnification in terms of the focal length and the distance of the image to the lens. 3 pts**

$Z =$

A.II.4 Determine the focal length of the lens.

2 pts

$f =$

**TASK A.III: CONTACT LENS**

A.III.1 In the Answer sheet circle the correct word on each line.

3 pts

- A. The trace is getting **bigger** **smaller** with the distance from the source.  
B. Given contact lens is **converging** **diverging**.  
C. Is it possible to see the image of any object displayed by the contact lens on the screen? **YES** **NO**.



**TASK B.II: ANALYSIS OF FORMALDEHYDE SAMPLE**

**B.II.1 Record the volume of standardized 0.1 M sodium thiosulfate used. 20 pts**

titration number		1.	2.	3.	mean:
Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub> consumption (mL)	start point				
	end point				
	difference				

**B.II.2 Calculate the mass of formaldehyde in the sample. Result should be expressed in milligrams (mg) of formaldehyde in the original sample provided. 3 pts**

Calculations:

Mass of formaldehyde in sample is:

**TASK B.III: SUPPLEMENTARY QUESTIONS**

**B.III.1 Use equations for describing the reaction of iodine with the following ions:**  
**3 pts**

- a)  $\text{SbO}_3^{3-}$  (antimonite)
- b)  $\text{SO}_3^{2-}$  (sulfite)
- c)  $\text{S}_2\text{O}_3^{2-}$  (thiosulfate) in neutral environment
- d)  $\text{S}_2\text{O}_3^{2-}$  (thiosulfate) in alkaline environment

**B.III.2 Which compounds (present at least two for each example) are used for the standardisation of following solutions?**  
**4 pts**

- a) Thiosulfate ( $\text{S}_2\text{O}_3^{2-}$ )
- b) Iodine ( $\text{I}_2$ )

**B.III.3 How many grams of  $\text{Na}_2\text{S}_2\text{O}_3 \cdot 5 \text{H}_2\text{O}$  are necessary for the preparation of 500 mL solution at concentration of 0.05 M ( $\text{mol} \cdot \text{l}^{-1}$ )?**  
**4 pts**

- $A_r(\text{Na})=23.0$
- $A_r(\text{S})=32.1$
- $A_r(\text{O})=16.0$
- $A_r(\text{H})=1.0$

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## C. Eye and vision 40 pts

### TASK C.I: VISION 6 pts

<b>C.I.1. Indicate if the following statements are true or false.</b>		<b>1.5 pt</b>	
A	While photoreception and photoreceptive pigments are phylogenetically very old, eyes developed independently many times in animal kingdom.	<b>TRUE</b>	<b>FALSE</b>
B	Photoreception, photoreceptive pigments as well as all animal eyes are phylogenetically very old and have a common origin.	<b>TRUE</b>	<b>FALSE</b>
C	While eyes are phylogenetically very old and of common evolutionary origin, different animal groups co-opted many different photoreceptive pigments.	<b>TRUE</b>	<b>FALSE</b>

<b>C.I.2. Indicate if the following statements are true or false.</b>		<b>1 pt</b>	
A	Animals living in dark developed pigments sensing ultraviolet light	<b>TRUE</b>	<b>FALSE</b>
B	Birds of prey possess higher concentration of neural elements such as rods and cones, therefore have much greater visual acuity than humans.	<b>TRUE</b>	<b>FALSE</b>

<b>C.I.3. Indicate if the following statements are true or false.</b>		<b>1 pt</b>	
A	Vision in mammals is restricted to a small range of electromagnetic spectrum; this varies from creature to creature, but is mainly between 400 and 700 nm.	<b>TRUE</b>	<b>FALSE</b>
B	Vision in organisms covers substantial part of the electromagnetic spectrum, varies from creature to creature, in majority invertebrates spans from ultraviolet to infrared wavelengths (100 – 1500 nm).	<b>TRUE</b>	<b>FALSE</b>

<b>C.I.4. Indicate if the following statements are true or false.</b>		<b>1 pt</b>	
A	The curvature of the human lens can be adjusted to "tune" the focus depending upon the object's distance.	<b>TRUE</b>	<b>FALSE</b>

B	Human lens have fixed shape, focusing is achieved by moving the lens forwards or backwards within the eye.	TRUE	FALSE
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<b>C.I.5. Indicate if the following statements are true or false.</b>		<b>1.5 pt</b>	
A	Mammals, except for primates, are colour-blind.	TRUE	FALSE
B	Most mammals posses dichromatic colour vision, they can distinguish blue from yellow-green but not red from green; they are red-green colour-blind	TRUE	FALSE
C	Sub mammalian vertebrates are colour-blind	TRUE	FALSE

**TASK C.II: CORNEA 11 pts**

<p><b>C.II.1. Draw with a pencil a schematic picture of the histological crossection to the Answer sheet and using following characteristics identify distinct cellular layers. Highlight them in the drawing using pencils with different colours. With the arrow mark the direction of the light entering the eye. 6pts +1 pt (quality of the microscopic specimen)</b></p> <p><b>A. Corneal epithelium (shade the area in RED):</b> a thin epithelial multicellular tissue layer (non-keratinized stratified squamous epithelium). It is composed of about 6 layers of cells which are shed constantly on the exposed layer.</p> <p><b>B. Corneal stroma (shade the area in BLUE):</b> a thick, transparent layer, consisting of regularly-arranged collagen fibers along with sparsely distributed interconnected keratocytes.</p> <p><b>C. Corneal endothelium (shade the area in GREEN):</b> a simple squamous or low cuboidal monolayer of cells responsible for regulating fluid and solute transport between the aqueous and corneal stromal compartments.</p>
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**C.II.2. One of the layers described in C.II.1. does not regenerate. Remnant cells stretch to compensate loss of the dead cells. The overall cell density of the particular layer therefore reduces with age. Which one of the 3 cell layers does not regenerate? Encircle the right answer. 1 pt**

- A
- B
- C

**C.II.3. Based on your observation of the histological specimen and your experience select the right answer/answers. Which of the following tissue types are localized in the cornea? Indicate if the following statements are true or false. 2 pt**

A	epithelial tissue	TRUE	FALSE
B	connective tissue	TRUE	FALSE
C	muscle cells	TRUE	FALSE
C	sensory neurons	TRUE	FALSE

**C.II.4. Based on your observation of the histological specimen and your experience indicate if the following statements are true or false. 1 pt**

A	The cornea has no blood supply; it gets oxygen directly through the air. Oxygen first dissolves in the tears and then diffuses throughout the cornea to keep it healthy.	TRUE	FALSE
B	The cornea is highly vascularised; it gets oxygen directly from the capillaries. Atherosclerosis leads to the loss of the corneal translucence called glaucoma, with causal treatment - corneal transplantation.	TRUE	FALSE

**TASK C.III: NON-KERATINIZED STRATIFIED SQUAMOUS EPITHELIUM 11 pts**

**C.III.1. Which dyes (A-D) stain basophilic structures (binds to acidic molecules, in the cells stain mostly nuclei)? Encircle the right answer(s). 2 pts**

- |   |       |      |
|---|-------|------|
| A | [YES] | [NO] |
| B | [YES] | [NO] |
| C | [YES] | [NO] |
| D | [YES] | [NO] |

**C.III.2. Which dyes (A-D) stain acidophilic structures (bind basic molecules, in the cell stain mostly cytosol)? Encircle the right answer(s). 2 pts**

- |   |       |      |
|---|-------|------|
| A | [YES] | [NO] |
| B | [YES] | [NO] |
| C | [YES] | [NO] |
| D | [YES] | [NO] |

**C.III.3. How a 96% ethanol fix the tissue sample? Indicate in the answer book if the following statements are true or false and circle the right answer. 1 pt**

- A [TRUE] [FALSE] Covalently modify macromolecules in the sample.
- B [TRUE] [FALSE] Dehydrate and therefore denature - in that way in non-water environment cellular components, mostly proteins dramatically change conformation.

**C.III.4. Identify and draw in the Answer sheet a cell covered with the bacteria, indicate which dye(s) (A, B, C or D) was(were) used for the staining of the specimen, where bacteria were easily visible. Indicate the bacteria with an arrows. 5 pts**

**C.III.5 The size of the buccal cell is about 100  - add appropriate metric system units in the box. 1 pt**

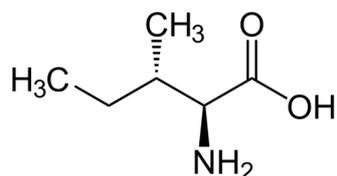
**IV. LENS 12 pts**

**C.IV.1 Draw in the Answer sheet (along with the molecular weight standards) position of the bands corresponding to the 4 major lens protein components named crystallins - soluble proteins that compose over 90% of the protein within the lens.**

Indicate corresponding estimated m.w. of individual crystallins. 4 pts

C.IV.2 Identify in the drawing (using an arrow) the edge of the gel where samples were loaded. 1 pt

C.IV.3 What is the approx. number of amino acids in the biggest crystalline? Below is a model structure of an amino acid with molecular weight close to the average amino acid molecular weight. 1 pt



C.IV.4 Amount of the protein in the crystalline band with highest molecular weight is about 10 micrograms. Sample loaded to the gel corresponds to the 1/500 of the total protein amount from one mouse lens. How many of these crystalline molecules contain visual system of a single mouse? 4 pts

C.IV.5. Indicate in the Answer sheet if the following statements are true or false. 2 pts

A	Lens proteins must last in a human for his/her entire lifetime	<b>TRUE</b>	<b>FALSE</b>
B	Important factor in maintaining the transparency of the lens is the absence of light-scattering organelles such as the nucleus, endoplasmic reticulum, and mitochondria within the mature lens fibers	<b>TRUE</b>	<b>FALSE</b>
C	Glucose is the primary energy source for the lens. As mature lens fibers do not have mitochondria, majority of the glucose is metabolized via anaerobic respiration.	<b>TRUE</b>	<b>FALSE</b>

**THAT'S ALL!**

**CONGRATULATIONS!**