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BIOPHYSICS LABORATORY NOTEBOOK

Name Surname_____

Group No. _____

Lecturer ----------

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1. VISCOSITY MEASUREMENT OF BIOLOGICAL LIQUIDS

Purposes:

- Determination of coefficient of viscosity by direct method (demonstrative experiment);
- Determination of coefficient of viscosity by relative method (Ostwald viscometer);
- Importance of viscosity in medicine.

Determination of coefficient of viscosity using the relative method

Working formula:

$$\eta = \eta_0 \frac{\rho \cdot t}{\rho_0 \cdot t_0} \qquad (1)$$

where η and η_0 are viscosity coefficients of the liquid and water, and ρ and ρ_0 are the densities of the liquid and water, respectively.

1. Draw by your hand the following figures from the book: Fig. 1.3 and 1.4

Table 1

No. of experiment	η_0, cP	$\rho_0, g/cm^3$	$\rho, g/cm^3$	t_0, s	t, s	η, cP
1						
2						
3						
4						
5						

2. Determine by calculations the viscosity coefficient for alcohol and insert the values in the table of measurements;

3. Write conclusions based on your own observations during the experiment and regarding the achieved results.

2. ULTRASOUND EFFECTS

Purposes:

1. Study of the methods of producing and receiving of the ultrasound;
2. Familiarization with physical and biological effects of the ultrasound;
3. Applications of ultrasound in practical medicine.

1. Draw by your hand the following figures from the book: Fig. 2.1, 2.2, 2.3 and 2.9

2. Write conclusions based on your own observations during the experiment.

3. DETERMINATION OF THE SURFACE TENSION OF THE BIOLOGICAL LIQUIDS

Purposes:

1. Presentation of theoretical notions about surface tension;
2. Study of the relative method of surface tension determination;
3. Determination of surface tension using the direct method;
4. Study of the importance of surface tension for medical practice.

Determination of the surface tension using the direct method

Working formulas:

The force, F, required to raise the ring from the liquid's surface is measured and related to the liquid's surface tension, σ:

$$F = \pi(d_1 + d_2) \cdot \sigma \tag{1}$$

or

$$\sigma = \frac{F}{\pi(d_1 + d_2)} = \frac{F}{2\pi d_{average}} \tag{2}$$

where d_1 is the inner diameter of the ring of the liquid film pulled and d_2 is the outer diameter of the ring of the liquid film. The system used in this laboatory is the torsion balance (see fig.3.4).

The force on the plate due to wetting is measured via a microbalance and used to calculate the surface tension using the Wilhelmy equation:

$$\sigma = \frac{F}{l\ cos\theta} = \frac{F}{2(l_1 + l_2)} = \frac{F}{l} \tag{3}$$

where l is the wetted perimeter ($l = 2l_1 + 2l_2$; l_1 is plate width and l_2 is plate thickness) of the Wilhelmy plate and θis the contact angle between the liquid phase and the plate. In practice the contact angle is rarely measured, instead either literature values are used, or complete wetting ($\theta = 0$) is assumed.

1. Draw by your hand the following figures from the book: Fig. 3.3 and 3.5.

Table 2

Concentration	#	$d\ (l), m$	F, dyn	$\sigma, dyn/cm$
0%	1			
	2			
	3			
	Average			
25%	Average			
50%	Average			
100%	Average			
X%	Average			

2. Determine by calculations the surface tension coefficient for all solutions and insert the values in the table of measurements.

3. Plot a graph where Ox corresponds to the concentration of solutions $n, \%$ and Oy- to the surface tension coefficient $\sigma, N/m$.
4. The $X\%$ for unknown solution is determined from the graphic dependence using the indications from teacher.

Use a millimeter paper!!

Attach the graph sheet here

5. Formulate the necessary conclusions based on your own observations during the experiment and regarding the achieved results from calculations and graph.

4. CELL OSMOTIC PHENOMENA

Purposes:

1. Presentation of theoretical notions of osmotic phenomena;
2. Study of devices applied for pointing out and measurement of osmotic pressure;
3. Familiarization with turgescent and plasmolysis phenomena;
4. Evaluation of the cell dimension by method of two micrometers;
5. Familiarization with biological and medical aspects of osmotic pressure.

1. Draw by your hand the following figures from the book: Fig. 4.1, 4.2, 4.4 and 4.5.

Table 4

No.of experiment	Hypotonic		Hypertonic	
	Transversal l_1	Longitudinal l_2	Transversal l_1	Longitudinal l_2
1				
2				
3				
4				
5				
Average				

2. Determine by the experiment the dimensions of the cells and introduce the results in the Table 4.
3. Formulate the necessary conclusions based on your own observations during the experiment and regarding the achieved results

5. DETERMINATION OF THE ION MOBILITY BY THE ELECTROPHORESIS METHOD

Purposes

- Study the phenomena which are on the base of electrophoresis method;
- Familiarization with application of electrophoresis method in biology and medicine;
- Study the electrophoresis equipment construction and electrophoresis separation of protein fractions of blood serum;
- Study of electrophoresis separation of inorganic ions (Cu^{2+} and Fe^{3+}) and visualization of colored ions moving into electrical field.

1. Draw by your hand the following figures from the book: Fig. 5.2.

Working formula:

$$M = \frac{v}{E} = \frac{\frac{l}{t}}{\frac{U}{d}} = \frac{l\,d}{U\,t} \qquad (1)$$

2. Knowing the distance of migration l, the interval of time t, the length d of the bands, and the voltage U, calculate the ion mobility for Cu^{2+} and Fe^{3+} using the working formula (1)

3. The table below needs to be filled with the experimental data.

Table 3

Nr of Experiment	***Ions***	U, V	t, s	d, cm	l, cm	$M, \frac{cm^2}{Vs}$
1	Cu^{2+}					
	Fe^{3+}					
2	Cu^{2+}					
	Fe^{3+}					
3	Cu^{2+}					
	Fe^{3+}					

4. Formulate the necessary conclusions based on your own observations during the experiment and regarding the achieved results from calculations.

6. SPECTRAL ANALYSIS

Purposes:

- Presentation of theoretical notions about spectral analysis;
- Familiarization with the dispersion phenomena;
- Study of the structure and work principle of the spectroscope with two tubes;
- Study of the applications of spectral analysis in medical-biological research.

1. Draw by your hand the following figures from the book: Fig. 6.1, 6.3, 6.4 and 6.5.

2. Table below needs to be filled with the experimental data.

Table 4

No	Color	Wavelength, λ, nm	Scale Reading, degree
Standart Hg			
1	Red	690	
2	Yellow	579	
3	Yellow	577	
4	Green	546	
5	Blue/Green	491	
6	Blue	436	
7	Violet	407	
	Sodium- studied substance		
	Yellow		

Example of calculation of the measured value:

Scale Reading: 6 div horizontal and 36 div vertical

$$\mathbf{6}\ \boldsymbol{div} \cdot \mathbf{1^0} + \mathbf{36} \cdot \mathbf{0.02^0} = \mathbf{6.72^0}$$

3. Plot the wavelength (in nanometers) versus the scale reading in degrees for each data point.

   Use a millimeter paper*!!!*

4. Draw a smooth curve that comes closest to all the data points. The curve is *not* a straight line. If all points except one fall very near the curve, recheck that point to insure that the correct spectral line was used. Draw the curve carefully because it will be used to determine the wavelengths for a studied substance- *Sodium.*

5. Record the scale readings of the yellow line of sodium on the data sheet. Draw straight a vertical line (use a ruler) at this position on your graph.

6. Draw straight a horizontal line (use a ruler) at this position where your vertical line intersect the curve you drew in part 6. Estimate the corresponding wavelengths for this sodium spectral line by reading (to the nearest nanometer) the values where your horizontal line intersects the y-axis. Record the results for this wavelength on the data sheet.

Attach the graph sheet here

4. Formulate the necessary conclusions based on your own observations during the experiment and regarding the achieved results

7. DETERMINATION OF WAVELENGTH AND ENERGY OF LASER RADIATION QUANTUM

Purposes:

- Presentation of theoretical notions about basic laser principles;
- Study of the structure and work principle of the He-Ne Laser;
- Determination of the wavelength and energy of quantum of laser radiation by means of the diffraction grating;
- Study of the applications of lasers in medicine and medical-biological research.

1. Draw by your hand the following figures from the book: Fig. 7.3, 7.5 and 7.9.

Working formula:

$$d \sin\theta = n\lambda \quad (1)$$

where d is the distance between adjacent slits,

θ is the angle the re-created image makes with the normal to the grating surface,

λ is the wavelength of the light, and n = 0, 1, 2, . . . is an integer of the maximum

$$\lambda = \frac{d}{n} sin\theta \approx \frac{d}{n} tg\theta \approx \frac{d}{n}\frac{S}{L} \quad (2)$$

$$\lambda = \frac{d}{n}\frac{S}{L} \quad (3)$$

where L is the distance from the grating to the screenand S is the distance from the central maximum ($n = 0$) and an onother maximum $n = 1,2, ...$

2. Calculate laser light wavelength using formula No (3).

3. Calculate laser light energy using formula $E = h\upsilon = \frac{hc}{\lambda}$

4. Introduce the obtained results in the table bellow:

Table 6

No	n	L, cm	S, cm	λ, nm	E, J
1					
Average No1					
2					
Average No2					
3					
Average No3					
Average					

5. Formulate the necessary conclusions based on your own observations during the experiment and regarding the achieved results.

8. DETECTION OF NUCLEAR RADIATION

Purposes:

- Presentation of theoretical notions about radioactivity, types of radiation and their interaction with living matter;
- Familiarisation with the radioactive decay types, activity and half-life time notions;
- Analysis of operations and working model of the nuclear radiation detectors;
- Detection of nuclear radiation by means of installation of B-4 type;
- Study of the applications of radioactive isotopes in medicine and medical-biological research.

1. Draw by your hand the following figures from the book: Fig. 8.2, 8.3, 8.5 and 8.6.

A. Determination of the counting speed of a Geiger-Muller counter

2. The obtained results needs to be introduced in the table below:

Table 7

No.	**Time** t, min	**Number of pulses** N	$n = \frac{N}{t}$
1	0.5		
2	0.5		
3	0.5		
4	0.5		
5	0.5		
Average			

B. Determination of the activity of a radioactive substance. The attenuation of radiation in different substances

3. The obtained results needs to be introduced in the table below:

Table 8

No.	**Distance** d, cm	**Number of pulses** N	**Activity** $n = \frac{N}{t}$
0			
1	5		
2	10		
3	15		
4	20		
5	25		

4. Draw the graphic of the function $n = f(d)$, analogously to the one represented in fig.8.12. ***Use a millimeter paper.***

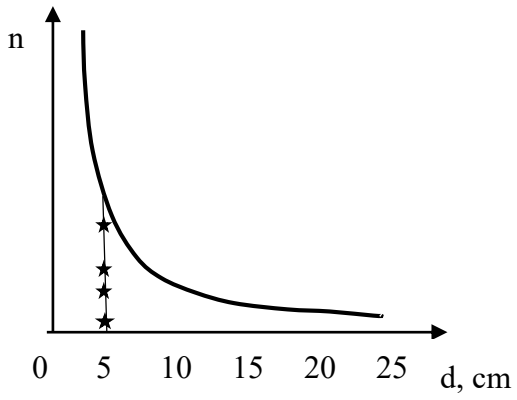

Fig.8.12. The dependence of counting speed on function of contour-source distance

5. Formulate the necessary conclusions based on your own observations during the experiment and regarding the achieved results

Attach the graph sheet here

9. DETERMINATION OF CONCENTRATION OF OPTICALLY ACTIVE SUBSTANCES BY POLARIMETRICMETHOD

Purposes:

- Study of physical phenomena that produce the polarized light;
- Study of some devices that produce the polarized light;
- Familiarisation with the possibilities of using the polarized light in medicine;
- Polarimeter construction and working principles.

1. Draw by your hand the following figures from the book: Fig. 9.1, 9.7, 9.8 and 9.9.

Working formula:

$$C_x = C\frac{\varphi_x}{\varphi}100\% \quad (1)$$

Note that here φ, C is the deviation angle and concentration for water, but φ_x, C_x is the deviation angle and concentration for the unknown solution, which is the glucose solution. The water concentration can be easily determined following the formula

$$C = \frac{10\varphi}{[\alpha]l}100\% \quad (2)$$

where l is the length of tube with solution, $[\alpha]$ is specific rotation and $\varphi$is the angle with witch the solution rotates the polarization plan of the polarized light.

2. Determine the unknown concentration following the formula (1)

3. Insert the results in the table of measurements:

Table 9

The researched solution	Experiment No.	φ_0, degree	φ', degree	$\varphi = \varphi' - \varphi_0$	C,%
1 (water)	1				
	2				
	3				
2 (glucose)	1				
	2				
	3				

4. Formulate the necessary conclusions based on your own observations during the experiment and regarding the achieved results from calculations.

10. STUDY OF COLORED SOLUTIONS BY FOTOCOLORIMETRY METHOD

Purposes:

- Study of the phenomenon about light absorption;
- Study of the construction and working principle of photoelectric colorimeter;
- Familiarization with colorimetric method applications in medicine;
- Using photoelectric colorimeter for the determination of the concentration of substances in solution.

1. Draw by your hand the following figures from the book: Fig. 10.1 and 10.3

Working formulas:

The ***optical transmission*** (transmission, transparency) of the substance is the ratio of the intensity of the light that passed through the substance I_d and incident light intensity I_0

$$\tau = \frac{I_d}{I_0} \quad (1)$$

The optical transmission coefficient (transparency) of the substance determines which part of the light passes through the substance (the solution) and it can be expressed in %.

The ***extinction*** coefficient (optical density) of the substance determines which part of the light is absorbed by the substance and is done by expression:

$$D = ln\left(\frac{1}{\tau}\right). \quad (2)$$

2. The obtained results needs to be introduced in the table below:

Table 10

The number of the solution.	C,%	τ,%	*D*
1.			
2.			
3.			
4.			
5.			
$X_{1.}$			
$X_{2.}$			

3. Draw the graph of the function $\tau = f(C)$ and a graph of the function $D = f(C)$. ***Use a millimeter paper.***
4. The X_1 and X_2 concentrations for unknown solutions are determined from the two graphic dependences using the indications from teacher.

Attach the graph sheet here

5. Formulate the necessary conclusions based on your own observations during the experiment and regarding the achieved results from calculations and graph.

Notes and suplimentary calculus

Biophysics laboratory notebook, 2017