12th EUROPEAN UNION SCIENCE OLYMPIAD

TASK A Athens, April 1st, 2014

BIOLOGY

TASK A.1: study of transpiration rate (34 marks)

A.1.1.

Assembly of the potometer **(*3 Marks*)** **checked by supervisor**

no bubbles (0.5 marks)

no leaks (0,5 marks)

dry leaves (0,5 marks)

potometer set up according to the scheme provided (1.5 marks) : water in the same horizontal level, water level in the pipette lower than 0, clamps in place that we can read measurements

Penalties: if asking help in the assembly of potometer 3 marks for full help, 1-2 marks for less .

If something unusual , out of safety instructions, destroy of equipment, penalty will be given after discussion between Ss. Committee an lab supervisors

Table 1 (room conditions) (***3 marks)***

Column C **waterloss mL/m²** 3 marks (0.5 x 6 measurements)

0.5 for each correct calculations according to the equation given

W = (Vt- Vo) / S

A.1.2 ***(3 Marks)***

Calculation of leaves surface

c. **leaf mass 1 m²** 1 Mark

d. leaf surface S 2 Marks

A.1.3 **Table 2** (light conditions) (***3 marks)***

Column C **waterloss mL/m²** (0.5 x6 measurement)

Same as A.1.1

A.1.4 (***3 Marks***)

same as A.1.2.

c. **mass 1 m²** 1 Mark

d. leaf surface S 2 Marks

A.1.5 **Drawing the graph** (***6 marks)***

0,5 mark: good utilisation of the paper or (maximum uses of graph paper) **0,5 mark: correct designation of the axes** **0,5 marks : correct division of the axes** **2.5 marks: Exact entry of values** **2 marks: "Best fit" lines**

Calculation of rate of transpiration (2 marks)

	marks
Correct way of calculation (graphically, or numeric)	**0.5 rate tr. RC** **0.5 rate tr. RC**
Tr rate LC > tr rate RC	**1**
Total	**2**
If no results	**0**

Question Bio 1 **(*1 mark*)**

Choose the correct answer based on your experimental measurements and the deduced graph

a. There are no differences in transpiration rate measured in either room conditions or light conditions

b. Light accelerates the transpiration rate

c. Light slows down the transpiration rate

correct answer is the one that is based on experimental measurements and the deduced graph

TASK A.1.6 **Depiction of the trichomes** ***(6 marks)***

***3 marks*: Quality o f microscopic slide preparation checked by supervisor**

Excellent 3 marks (no bubbles, clear , proper light, more than one trichome visible)

Fair 2 mark

Poor 1 mark

***3 marks*: Drawing microscopic slide (scientific not artistic representation!)**

Clear continuous line drawing , there should be no shading 1 mark

Proper and written magnification 1 mark

Drawing that fills the most of the provided place 1 mark

Question BIO 2 **(1 mark)**

Select the single best answer

Capillaries on olive leaves:

A. are a morphological structure that blocks entry of rain water into the leaves

B. are a morphological adjustment that prevents water evaporation by the stomata

C. have no significant functional role and only serve to make leaves more attractive

D. protect the leaves from excessive exposure to the sun

B

Additional questions

Question Bio 3 ***1 mark*** (2x 0,5 each)

A potometer was used to measure water loss in a leafy plant shoot. The following readings were obtained:

	Conditions	Time required for water to move 10 mm (in sec)
1	cold, wind current, sunny	8
2	cold, no wind current, sunny	24
3	Hot, wind current, sunny	4
4	Hot, no wind current, sunny	12
5	Hot, no wind current, dark	360

Question a: At which conditions was transpiration higher? **(3)**

Question b: At which conditions was transpiration lower? **(5)**

Question BIO 4 ***2 marks (4x 0,5 each)***

Trees (e.g. olive trees) found in Mediterranean countries, known for long periods of sunshine and drought, are able to survive due to their specialised morphological and functional adjustments.

Decide whether the statements below are True (T) or False (F).

A. Leaves on these trees have a large surface F

B. These trees have thick and leathery leaves T

C. Leaves on those trees contain morphological structures, which restrict transpiration T

D. These trees have significantly more stomata compared to plants that reside in humid and darker environments F

TASK A1 : TOTAL MARKS 34

TASK A CHEMISTRY

In the following questions, circle the correct answer where appropriate.

Che 1. During the experiment, $CHCl_3$ is used **1 Mark**

- as a solvent
- b) to increase the rate of the reaction
- c) to avoid oxidation of the sample
- d) to increase the yield of the reaction

Che 2. The conical flask is placed in the dark for 5 minutes **1 Mark**

- a) to avoid nitrogen in the air affecting the sample
- b) to avoid a reaction between the oxygen in the air and the sample
- to avoid any undesirable photochemical activity
- d) to avoid any reducing activity by the air

Che 3. During the titration, a color change was observed due to the presence of a substance which acted as an indicator. Which of the compounds used during the experiment acted as the indicator?

1 Mark

- a) $Na_2S_2O_3$
- b) KI
- c) CH_3COOH
- starch

Che 4. Complete Table 1 below and carry out all necessary calculations bellow.

Table 1: Olive oil Sample A **5 Marks**

	1st titration	2nd titration	3rd titration
Mass of Olive oil (g)			
Initial Volume of $Na_2S_2O_3(aq)$ (mL)			
Final Volume of $Na_2S_2O_3(aq)$ (mL)			
Volume of $Na_2S_2O_3(aq)$ used (mL)			
Peroxide Value (PV) (mmol/Kg)			
Average Peroxide Value (PV)	**5.3**		

Calculations **2.5 Marks**

Che 5. Complete Table 2 below and carry out all necessary calculations bellow.

Table 2: Olive oil Sample B **5**

Mark

	1st titration	2nd titration	3rd titration
Mass of Olive oil (g)			
Initial Volume of $Na_2S_2O_3(aq)$ (mL)			
Final Volume of $Na_2S_2O_3(aq)$ (mL)			
Volume of $Na_2S_2O_3(aq)$ used (mL)			
Peroxide Value (PV) (mmol/Kg)			
Average Peroxide Value (PV)	**11.7**		

Calculations **2.5 Marks**

Che 6. When you compare the Peroxide Values (PV) for the two oils, which one do you think is more suitable for eating? 1 Mark

Sample A

b) Sample B

Che 7. You are given two samples of oil (samples C and D). Sample C has been stored in an open container for 5 months, while sample D has been recently manufactured. Is it possible to identify the two samples by measuring the PV for each? 1 Mark

a) Yes, because 5 months is required to deteriorate the sample oil

b) No, because PV remains constant over time

Yes, because PV increases with time

d) No, because storage occurs in an open container

Task A3 - Evaluation Sheet - Physics

Viscosity and Refractive Index of Olive-Oil

Malpractice during the experimental procedure may lead to deduction of 0-16 points.

Task A3.1 - Measuring the olive-oil coefficient of viscosity

[Use the correct number of significant figures in measurements and calculations]

Proof of relationship (5)

2 points

A3.1a Measurement of the radius r of the plastic spheres in cm. Calculation of their mass, in grams (g). Experimental calculation of the density ρ_s of the spheres.

Experimental calculation of the density (ρ_{ol}) of olive-oil.

Calculations:

r = _____ cm

m = _____ g

ρ_s = _____ g/cm^3

ρ_{ol} = _____ g/cm^3

ρ spheres (g/mL)	***ρ*** olive-oil (g/mL)	***r*** spheres (cm)
1.06	**0.92**	**0.30**

[Measurement of the radius *r* of the spheres with a relative deviation from the experimental value less than 10% (1 p) - Measurement of the mass *m* of the spheres with a relative deviation from the experimental value less than 10% (1 p) - Experimental calculation of the density ρ_s of the spheres with a relative deviation from the experimental value less than 10% (1 p) - Experimental calculation of the density ρ_{ol} of the olive-oil with a relative deviation from the experimental value less than 10% (1 p)]

Total: 6 marks

A3.1b Calculation of the viscosity coefficient of olive-oil: follow the instructions described in step A3.1b of the work-sheet and fill-in table B:

TABLE B olive-oil (L=10cm)							
time t (s)					mean-time (s)	v (cm/s)	viscosity coefficient (Pa.s)
4,30	**4,10**	**4,20**	**4,15**	**4,25**	**4,20**	**2,38**	**0,12**

[Motion of spheres inside the olive-oil:

We calculate the relative deviation α_η of the viscosity coefficient of olive-oil from the experimental values. We give: 5 p, if $\alpha_\eta \leq 10\%$ - 2 p if $10\% < \alpha_\eta \leq 20\%$ - no points, if $20\% < a$ - We subtract 1 p if there is an arithmetic mistake only in the calculation of the viscosity coefficient]

Total: 5 marks

Total points for task A3.1: 11 marks

Task A3.2 - Measuring the refractive index of olive-oil

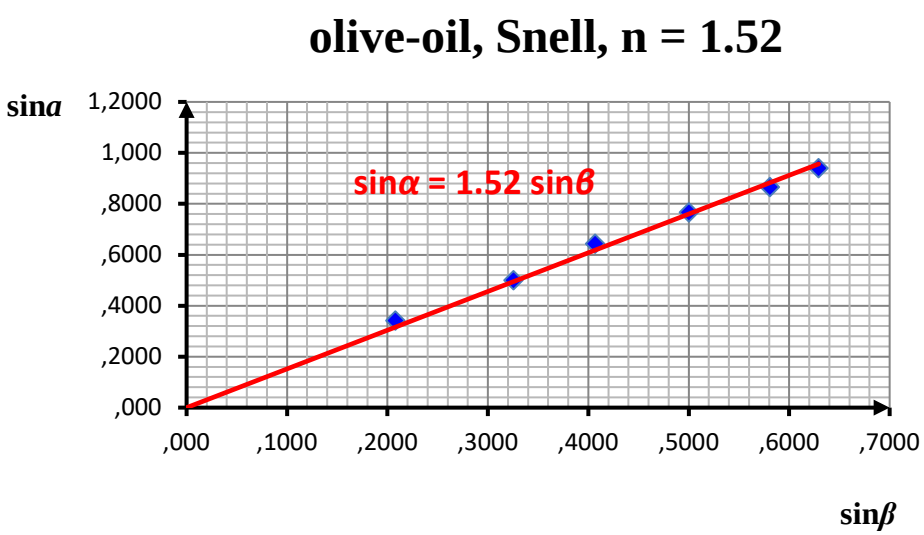
From Ptolemy's law to Snell's law

A3.2a Record the measurements of the refractive angle β at the cells of the second column of table C1

TABLE C1					
angle of incidence α (degrees)	refraction angle β (degrees)	$\sin\alpha$	$\sin\beta$	$n_j=\sin\alpha_j/\sin\beta_j$	$n'_j=\alpha_j/\beta_j$
30	**19**	0.500	**0.326**	**1,54**	**1,58**
40	**24**	0.643	**0.407**	**1,58**	**1,67**
50	**30**	0.766	**0.500**	**1,53**	**1,67**
60	**35.5**	0.866	**0.581**	**1,49**	**1,69**
70	**39**	0.940	**0.629**	**1,49**	**1,79**

A3.2b Experimental calculation of the refractive index of olive-oil.

Fill in the 4th column of table C1. On graph paper, draw a system of two orthogonal axes Ox ($x = \sin\beta$) and Oy ($y = \sin\alpha$). According to the instructions of the worksheet, draw the best-fit line for the experimental points, which is also going through the point (0, 0). Determine the slope of this line and the refractive index of olive-oil (n_{oil}).



Calculations:

_____

____

n_{oil} =**1.52**

[Fill the second and fourth column of table C1: 0,4 p for every cell, given that the relative deviation from the corresponding experimental value of Appendix 1 is less than 10% (10 cells x 0,4 p = 4 p).

Draw and name axes (1 p) - Scale choice in every axis (1 p) - Plot experimental points (0,4 p for every point: 5x0,4 p = 2 p) - Plot the straight line (2 p) - Find slope and refractive index of olive-oil (2 p).

We calculate the relative deviation *α* of the refractive index of olive-oil from the experimental value. Give: 3 p, if $a \leq 10\%$ **- 1 p, if** $10\% < a \leq 20\%$ **- no points, if** $20\% < a$ **]**

Total: 15 marks

A3.2c Deviation of the experimental data from the theoretical predictions of Snell's law

Based on the experimental data recorded in table C1, fill in the 5th column of table C1. Calculate the deviation A_{Snell} of the experimental data from Snell's law predictions (to be helped, fill in the first and second columns of table C2). Express A_{Snell} in % percentage.

Show your calculations analytically:

TABLE C2			
nj (Snell)	deviations (Snell) $A_j = \left\lvert \frac{n_j - n_{oil}}{n_{oil}} \right\rvert$	n'j (Ptolemy)	deviations (Ptolemy) $A'_j = \left\lvert \frac{n'_j - n'_{oil}}{n'_{oil}} \right\rvert$
1.54	**0.010**	**1.58**	**0.077**
1.58	**0.040**	**1.67**	**0.025**
1.53	**0.008**	**1.67**	**0.025**
1.49	**0.019**	**1.69**	**0.012**
1.49	**0.018**	**1.79**	**0.050**
Mean deviation (Snell)		Mean deviation (Ptolemy)	
0.019		**0.038**	

Calculations:

_____

_____

A_{Snell} = .

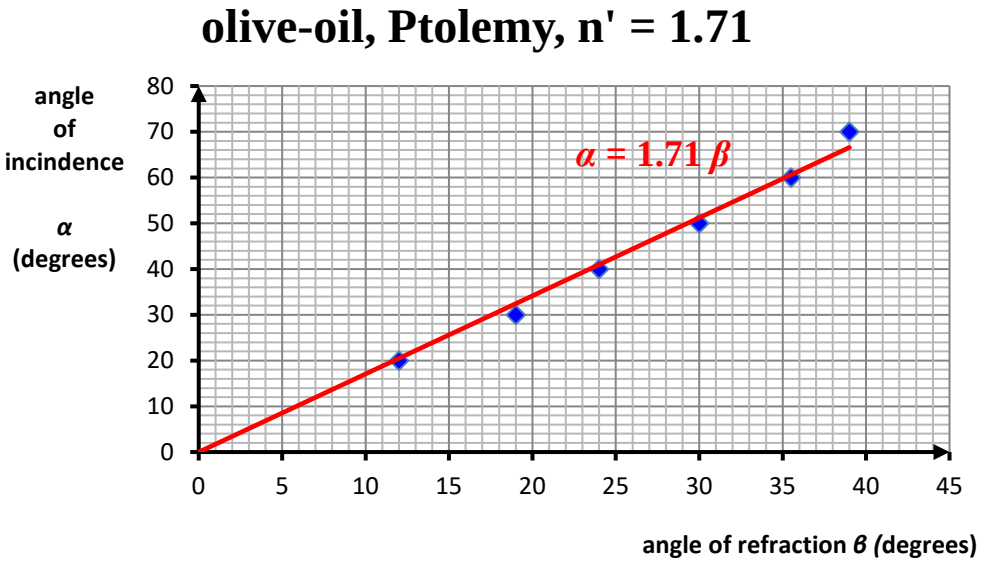
[Fill in the 5th column of table C1: 0,4 point for each cell (0,4x5=2 points). Calculation

of A_{Snell} value: if A_{Snell} is less than 5%, give 3 points - if it is between 5% and 10%, give 1 point - no points, if it is greater than 10%]

Total: 5 marks

A3.2d Recursion in history: The law of Claudius Ptolemy

Based on table C1 and the instructions given in step A3.2d of the worksheet, draw the experimental straight line $a = n'_{oil} \cdot \beta$. Find its slope, and so determine the refractive index (n'_{oil}) of olive-oil, according to Ptolemy's law.



Calculations:

_____

_____

n'_{oil} = **1.71.**

[Draw and name axes (1 p) - Scale choice in each axis (1 p) - Plot experimental points (0,4 p for each point: 5x0,4 p = 2 p) - Plot of straight line (2 p) - Find slope and

determine the refractive index of olive-oil, according to Ptolemy's law (2 p).

Calculate the relative deviation *α* of the refractive index of olive-oil, according to the Ptolemy's law, from the experimental value given in Appendix 1. Give: 3 p, if $a \leq 10\%$ **- 1 p, if** $10\% < a \leq 20\%$ **- no points, if** $20\% < a$ **]**

Total: 11 marks

Fill in the 6th column of table C1. Calculate the deviation $A_{Ptol.}$ of the experimental data from the theoretical predictions of Ptolemy's law, according to relationship (5) of the part A3.2d of the worksheet (to be helped, fill in the third and fourth column of table C2). Express $A_{Ptol.}$ in % percentage.

Calculations:

_____

_____

$A_{Ptol.}$ = _____

[Fill in the 6th column of table C1: 1 point for each cell (0,2x5=1 p). Calculation of the $A_{Ptol.}$ **: If** $A_{Ptol.}$ **is less than 10%, give 3 points - if it is between 10% and 20%, give 1 points - no points, if it is greater than 20%]**

Total: 4 marks

Choose the theory that seems best: A) Snell's? B) Ptolemy's?

Total marks for task A3.2: 35 marks

Total marks for the task A.3 - Physics (A3.1 and A3.2) = 11 + 35 = 46 marks