VILNIUS 2012

24th of April 2012

Experiment 1

Marking

Amber

Answer sheet

Task 1.1.1. Use the "Key to arthropods" to identify the samples in each plate.

Plate Nr.	Write down the number from the key that corresponds to each step (write numbers that you follow from the key, like 1, 28. 48 and so on)																	
1.	**1**	**2**	**10**	**13**	**13A**													
2.	**1**	**28**	**48**	**49**	**50**	**66**	**72**	**73**	**75**	**76**	**81**							
3.	**1**	**28**	**48**	**49**	**50**	**66**	**72**	**73**	**75**	**76**	**81**							
4.	**1**	**28**	**48**	**49**	**50**	**66**	**72**	**73**										
5.	**1**	**28**	**48**	**49**	**50**	**66**	**67**	**68**										
6.	**1**	**28**	**29**	**30 36**	**33 37**	**34 38**	**39**	**40**	**65**									
7.	**1**	**28**	**29**	**36**	**43**	**44**	**45**											

0.1 point is given for every correct step answer in the cell, total – **5.6** points (except three last steps in alternative way for the plate 6, so that number of correct steps is equal for everyone)

Task 1.1.2. Name the arthropod that you have identified in each plate**.** Write down the name of the arthropod for each of the seven plates:

Plate number	Name of the arthropod in Latin based on the key
1	Isopoda
2	Pollenia
3	Syrphidae
4	Bibionidae
5	Trichoceridae
6	Trichoptera
7	Coleoptera

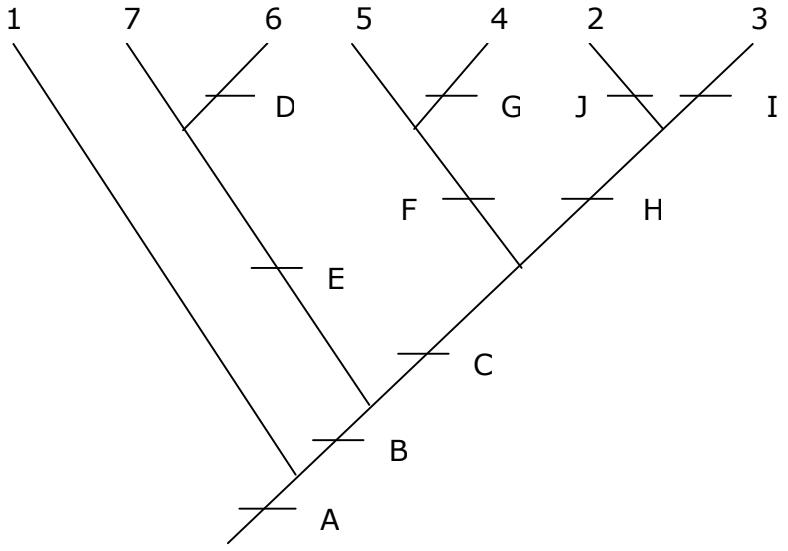
1 point is given for every correct answer in the cell, total – 7 points.

Task 1.2.1. Indicate the correct character states (0 or 1).

Arthropods from:	**Characters**									
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**
Plate 1.	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Plate 2.	**1**	**1**	**1**	**0**	**0**	**0**	**0**	**1**	**0**	**1**
Plate 3.	**1**	**1**	**1**	**0**	**0**	**0**	**0**	**1**	**1**	**0**
Plate 4.	**1**	**1**	**1**	**0**	**0**	**1**	**1**	**0**	**0**	**0**
Plate 5.	**1**	**1**	**1**	**0**	**0**	**1**	**0**	**0**	**0**	**0**
Plate 6.	**1**	**1**	**0**	**1**	**1**	**0**	**0**	**0**	**0**	**0**
Plate 7.	**1**	**1**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**

0.1 point is given for every correct symbol in the cell, total – 7 points.

Task 1.2.2. Put all the letters of characters (A to J) in appropriate places on the given tree (as shown in the example in Fig. 5). Write the respective plate number (1-7) at the end of each branch.



0.1 point is given for every correct name (number) at the end of the branch (total 0.7 points), and 0.42 points are given for every letter in correct place (total 0.42 points). Grand total – 4.9 points

Correct versions of the tree:

1, 7, 6, 5, 4, 2, 3	1, 7, 6, 5, 4, 3, 2

Task 1.2.3 The most expensive piece

Plate number: _____1_____. 0.5 points

End of **Task 1.**

TASK 2: Colour and intensity of colour measurements

Task 2.1.1. Calculate the volumes of petroleum ether and ethyl acetate needed to prepare 5 ml of the following eluents (1 pt):

v : v ratio (petroleum ether : ethyl acetate)	$V_{petroleum\ ether}$, mL	$V_{ethyl\ acetate}$, mL
9:1	5.0·0.9=4.5 mL	5.0·0.1=0.5 mL
3:1	5.0·0.75=3.75 mL	5.0·0.25=1.25 mL

0.5 pts for each correct volume ratio

Task 2.1.2. Calculate the R_f values for every spot in each of the TLC plate. Show your calculations. (2 pts)

	9:1	3:1	„Eluent"
R_f(yellow)	$R_f = h_{spot}/h$ R_f = 0.44	$R_f = h_{spot}/h$ R_f = 0.58	$R_f = h_{spot}/h$ R_f = 0.49
R_f(red)	$R_f = h_{spot}/h$ R_f = 0.20	$R_f = h_{spot}/h$ R_f = 0.44	$R_f = h_{spot}/h$ R_f = 0.28

All calculations showed – 1 pt; correct values – 1pt.

Task 2.1.3. Finish the sketch of the TLC plate, which was developed using mobile phase from the flask "Eluent". (1 pt)

*If R_f values in the sketch are equal to the ones calculated in Task **2.1.2.** – 1 pt.*

Task 2.1.4. What is the concentration of ethyl acetate in the flask "Eluent"? (Circle the correct answer)(1 pt)

a) 0-10% b) 10-25% c) 25-40% d) 40-70% e) 70-100%

1 pt for correct answer

Task 2.1.5. What are the minimum and maximum values for R_f? (Circle the correct answer) (1 pt)

a) -∞; 0 b)-∞; 1 <u>c) 0; 1</u> d) 0; +∞ e) -∞; +∞

1 pt for correct answer

Task 2.1.6. What is the most suitable eluent for separation of the mixture in thin layer chromatography? (Circle the correct answer)(1 pt)

a) giving both R_f values as high as possible

b) giving both R_f values as low as possible

c) giving the sum of R_f values equal to 1

<u>d) giving the highest difference between R_f values</u>

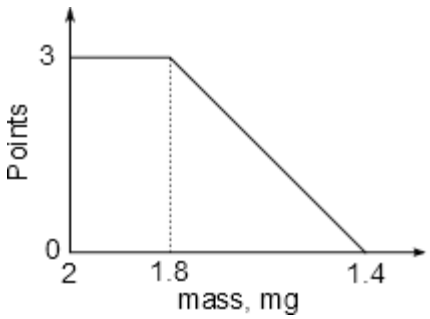
e) giving the difference between R_f values smaller than 0.10

1 pt for correct answer

Task 2.2. The effectiveness of your colorant separation will be evaluated for maximum 7 pts.

The mass of every separated colorant will be calculated using spectrophotometer.

The points for both colorants are given according to the scheme:



No red colorant in the yellow solution – 0.5 pts.

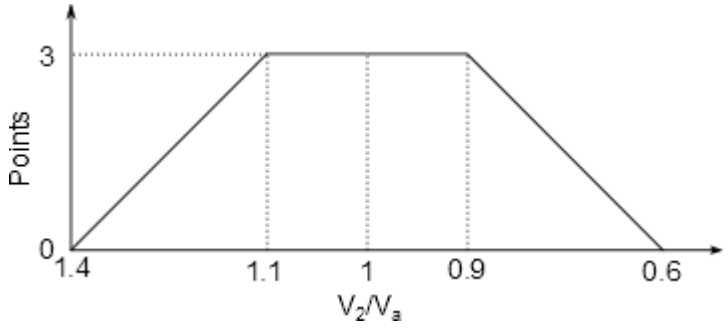
No yellow colorant in the red solution – 0.5 pts.

Task 2.3.1. Complete the table. (3 pts)

Yellow colorant			
Volume of collected fraction (from Task2.2)			V_1 =
Experiment number	V_{min}	V_{max}	$V_2 = \frac{V_{max} + V_{min}}{2}$

1			
2			
3			
4			
5			
The value you choose to use in future calculations			V_2 =

The volume V_2 will be compared with the theoretical volume V_a calculated from spectrophotometric data. The points are given according to the scheme:



Task 2.3.2. Calculate the quantity of the yellow colorant in the analyzed mixture in <u>milligrams</u>. (1.5 pts)

Calculations m=0.01V_2 Answer: m_{yellow} =

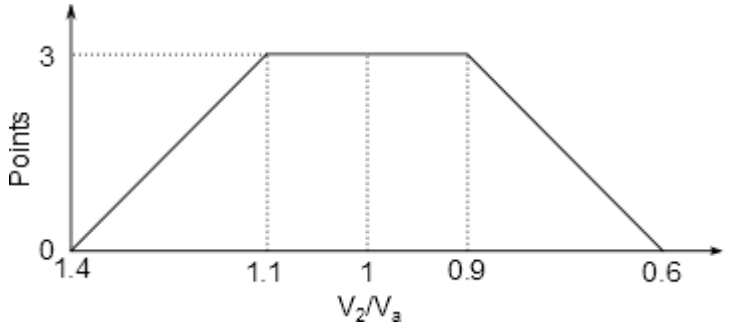
Calculations with correct answer – 1 pt, expression in milligrams – 0.5 pts.

Task 2.3.3. Complete the table. (3 pts)

Red colorant			
Volume of collected fraction (from Task 2.2)			V_1 =
Experiment number	V_{min}	V_{max}	$V_2 = \frac{V_{max} + V_{min}}{2}$
1			
2			

3			
4			
5			
The value you choose to use in future calculations			V_2 =

The volume V_2 will be compared with the theoretical volume V_a calculated from spectrophotometric data. The points are given according to the scheme:

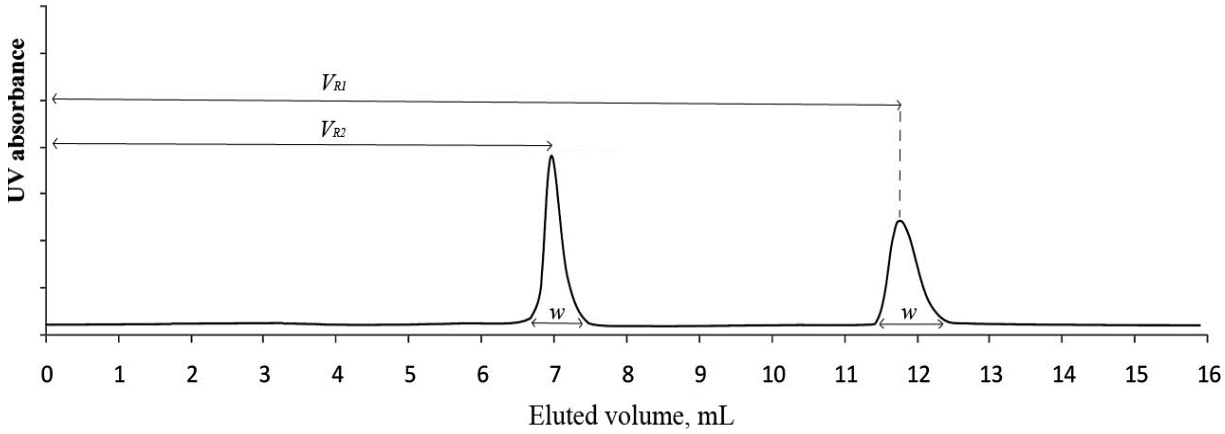


Task 2.3.4. Calculate the quantity of the red colorant in the analyzed mixture in <u>milligrams</u> (1.5 pts)

Calculations $m=0.01V_2$ Answer: m_{red} =

Calculations with correct answer – 1 pt, expression in milligrams – 0.5 pts.

Task 2.4.1. The given figure represents chromatographic separation of two colorants. Eluted mobile phase volume is plotted on X axis and Y represents detector`s signal. The ***retention volume V_R*** is the volume of mobile phase passed through the column between the start point and the peak maximum. The ***retention time t_R*** of a solute is taken as the elapsed time between the start time and the time of elution of the peak maximum of that solute. ***Theoretical plates N*** is the value which describes chromatographic column`s efficiency. ***W*** is peak base width in mL. Use the given formulas and chromatographic results plotted in Figure 1 to calculate N values. ***F*** is the volumetric mobile phase rate and it is 1 mL/min under the current case. (2 pts)



$$V_{R_i} = t_{R_i} \times F$$

$$N_i = 16 \times \left(\frac{t_{R_i}}{w_i}\right)^2$$

Calculations

From the graph: V_{R1} = 11.8 ± 0.1 mL; V_{R2}= 7.0 ± 0.1 mL (0.25 each)

w_1= 12.3 -11.4 = 0.9 ± 0,1 mL; w_2= 7.3 -6.7 = 0.6 ± 0,1 mL (0.25 each)

F = 1,0 mL/min (from the task)

Calculating t_R: $t_R = \frac{V_R}{F}$; t_{R1} = 11.8 ± 0.1 min; t_{R2}= 7.0 ± 0.1 min. (0.25 each)

$$N_1 = 16 \times \left(\frac{11.8 \pm 0.1}{0{,}9 \pm 0.1}\right)^2 = [2200 - 3500]$$

$$N_2 = 16 \times \left(\frac{7.0 \pm 0.1}{0{,}6 \pm 0.1}\right)^2 = [1500 - 3300]$$ (0.25 each)

Answer: N_1= Interval [2200 – 3500] N_2= Interval [1500 – 3300]

End of **Task 2.**

TASK 3. The density distribution of amber

Task 3.1.1. The total mass of NaCl in initial solution is (write the equation):

$m_{\mathrm{NaCl}} = V_1 \rho_1 c_1$ *(1 point)*

Task 3.1.2. The mass of water m_w in initial NaCl solution (write the equation):

$m_w = V_1 \rho_1 (1 - c_1)$ *(1 point)*

Task 3.1.3. The total mass of mixed solution of fluids is (write the equation):

$m = V_1 \rho_1 + V_0 \rho_0$ *(1 point)*

Task 3.1.4. Mass concentration in the mixed solution is (write the equation):

$c = \frac{m_1}{m}$

(1 point)

Task 3.1.5. Ratio of volumes V_0 and V_1 as a function of c is (write the calculations):

$$\frac{V_0}{V_1} = \frac{\rho_1 (c_1 - c)}{\rho_0 c}$$ *(2 points)*

Task 3.1.6. Ratio of volumes V_0 and V_1 as a function of ρ is:

We should realize that $\rho = \alpha c + \rho_0$, here α is some constant (see Fig. 1 in Task sheet). Find $c = \frac{\rho - \rho_0}{\alpha}$. Substitute this value with? the formula from 3.1.5:

a) $\frac{V_0}{V_1}(\rho) = \frac{\rho_1 (\rho_1 - \rho)}{\rho_0 (\rho - \rho_0)}$ (2 points)

b) $V_1 = V_0 \frac{\rho_0 (\rho - \rho_0)}{\rho_1 (\rho_1 - \rho)}$ (1 point) (total 3 points)

TABLE 3.1.: (5.5 points)

Density of solution (g/cm^3) (ρ)	Recommended volume of distilled water (ml) (V_0)	Volume of NaCl 13.0 % solution (ml) (V_1)	The number of newly surfaced pieces of amber (n)	The percentage of newly surfaced pieces of amber of the tota number (%)
1.030	80	*31.2*	*0*	0
1.035	70	*34.3*	*2*	1
1.04	60	*36.4*	*3*	1.5
1.045	60	*44.6*	*6*	3
1.050	50	*45.5*	*8*	4
1.055	50	*55.6*	*10*	5
1.060	40	*54.5*	*28*	14
1.065	40	*67.5*	*57*	28.5
1.070	30	*63.6*	*31*	15.5
1.075	30	*81.8*	*20*	10
1.080	20	*72.7*	*21*	10.5
1.085	15	*77.3*	*12*	6
1.090	10	*81.8*	*10*	5
1.095	5	*86.4*	*4*	2
1.100	0	*50*	*0*	0

Quantity of NaCl 12.5% solution: 0.1 point is given for every correct value calculated from the task 3.1.6., total – **1.5** points. *The number of newly surfaced pieces of amber:* 0.1 point is given for every correct value, total – **1.5** points. *The number of newly surfaced pieces of amber(in %):* 0.1 point is given for every correct value, total – **1.5** points. **1** point if the table is completed.

Task 3.1.8. replace the formulation *(5 points)*

Draw axis – **1** pt. Suitable size of the chart (3/4 of page) – **1** pt, less 0.5 pt. Correct scale - **0.5** pt. Correct values on the axis – **1.5** pt. Both units on the axis – **1** pt.

Task 3.1.9. The density interval of amber that corresponds to the highest number of newly surfaced pieces of amber is:

ρ_{amber}= [see from the chart] *(1pt)* [g/cm^3] *(0.5pt)* *(1.5 points)*

Task 3.1.10. The sphere shape "Sun Stone" has:

volume $V = \frac{4}{3}\pi r^2$ = 3313.6 *(1pt)* [cm^3] *(0.5pt)*

ρ_{amber}= m/V= 1.064 *(1pt)* [g/cm^3] *(0.5pt)* *(total 3 points)*

Task 3.1.11 According to the experiment, please explain: 'Why does amber found in the sea usually have an irregular shape, compared to other stones which look more rounded and polished?' Circle the correct answer.

a) Amber is buoyant in salt water *(0pt)*

b) Amber is cut of the big piece *(0pt)*

c) The stones having considerably higher density are much heavier in water in comparison to amber *(1 pt)*

d) Stones are intensely etched in salt water while amber is not *(0pt)*

End of **Task 3.**

Task 4.1. Amber evaluation catalogue

Task 4.1.1. Derive the formula for initial amber value (in swords). (1 pt.)

Amber evaluation table according to mass

Mass of amber (g)	Initial amber value (swords, spears and arrows)
1 g	1 arrow
5 g	2 spears and 5 arrows (25 arrows)
10 g	1 sword (100 arrows)
15 g	2 swords, 2 spears and 5 arrows (225 arrows)
Initial amber value (in swords) is calculated by formula: 1 g – 1 arrow 5 g – 25 arrows 10 g – 100 arrows 15 g – 225 arrows Formula m2 (arrows) (0.5 pt.) or m2/100 (swords) (1 pt.)	

Task 4.1.2. According to the results, obtained in **Task 2**, calculate "Sun Stone" coefficient value with regard to colour tone, using the table below. (1 pt.)

Amber evaluation tables according to colour tone

Colour tone (m_{red}/m_{yellow})	Coefficient
∞	2.00
3	1.75
1	1.50
1/3	1.25
0	1.00
m_{red}/m_{yellow}: 0.2 / 0.2 = 1 Coefficient: : 1.5 100 % (mred) – 2.00 …… % (mred) - x	

Task 4.1.3. Assuming that the colorant mixture for Column Chromatography was obtained from a 1 g sample of "Sun Stone", calculate the coefficient value with regard to colour intensity. You will need to use your data from **Task 2** and the data below. (1 pts.)

Amber evaluation table according to intensity

Colour intensity $((m_{red}+m_{yellow})/m_{amber})$	Coeficient
0.0010	0.10
0.0025	0.25
0.0050	0.50
0.0075	0.75
0.0100	1.000
$(m_{red}+m_{yellow})/m_{amber}$: (0.0002 + 0.0002)/1 =0.0004 Coefficient: 0.0010 – 1.00 0.0004 – x x= 0.4	

Task 4.1.4. What is the percentage value loss of the "Sun Stone" according to its density distribution?

Use the density value of the "Sun Stone" from **Task 3.1.10** and find the corresponding percentage according to the density distribution in **Table 3.1** of **Task 3.1.7** or the chart from **Task 3.1.8**. This percentage would be the reduction in the value of the "Sun Stone". (0.25 pts)

3% – 15 % (0.25 points awarded) 0 points awarded outside this range

Task 4.1.5 It was found that "Sun Stone" contains inclusions, the same that you determined to be the most valuable in **Task 1.2.3.** Calculate what additional value (in swords, spears and arrows) the most valuable inclusion adds to total price. (0.25 pts)

Name of inclusion (from **Task 1.2.3**): Isopoda Additional value in swords, spears and arrows: 131 swords, 1 spear and 2 arrows
Full points for using correct value from the table

Added value of amber according to the type of inclusion

Eil. Nr.	Name of inclusion	Added value
1.	Coleoptera	5 swords
2.	Psocoptera	6 swords, 3 spears
3.	Aphidoidea	7 swords, 6 arrows
4.	Dolihopodidae	8 swords
5.	Trichoptera	10 swords, 5 spears and 5 arrows
6.	Lepidoptera	15 swords, 8 spears
7.	Simuliidae	17 swords, 6 arrows
8.	Hemiptera	20 swords, 9 arrows
9.	Trichoceridae	27 swords, 3 spears
10.	Orthoptera	30 swords, 5 spears and 7 arrows
11.	Empididae	35 swords, 6 spears and 1 arrow
12.	Ephemeroptera	41 swords, 2 spears and 2 arrows
13.	Culicidae	48 swords, 4 spears and 4 arrows
14.	Bibionidae	52 swords, 1 spear and 7 arrows
15.	Mantodea	63 swords, 3 spears and 5 arrows
16.	Embioptera	68 swords
17.	Syrphidae	70 swords, 6 arrows
18.	Plecoptera	84 swords, 2 spears and 3 arrows
19.	Psychodidae	103 swords, 1 spear and 1 arrow
20.	Pollenia	120 swords, 9 spears and 7 arrows
21.	Chilopoda	121 swords, 3 spears and 4 arrows
22.	Strepsiptera	123 swords, 2 spears
23.	Siphonaptera	125 swords, 5 spears and 5 arrows
24.	Solpugida	128 swords, 6 arrows
25.	Isopoda	131 swords, 1 spear and 2 arrows

Task 4.1.6. Calculate the hypothetical value of "Sun Stone" in the Phoenician market (in swords, spears and arrows).Always use the value derived from previous row to calculate the value in the next row. Show your calculations. (1.5 pts)

Initial value of "Sun Stone" according to mass	3526.32 x 3526.32 /100 = 124329 swords, 3 spears and 3 arrows (12434933 arrows)
Specified "Sun Stone" value according to colour tone	12434933 x 1.5 = 248698 swords, 6 spears and 6 arrows (24869866 arrows)
Specified "Sun Stone" value according to colour intensity	24869866 x 0.4 = 99479 swords, 4 spears and 6 arrows (9947946 arrows)
Specified "Sun Stone" value according to its density	For example: value is 5 % 9947946 x 0.95 = 94505 swords, 4 spears and 9 arrows (9450549 arrows)
The final value of "Sun Stone" taking into account the additional value of inclusion	94505 swords, 4 spears and 9 arrows (9450549 arrows) + 131 swords, 1 spear and 2 arrows (13112 arrows) = 94636 swords, 6 spears and 1 arrows

Each part – 0.3 pts; full marks for correct calculations;