Question A1.1 Based on the measured data you collected in the table above, determine the closest average values at each time point in each condition!

(16 points)

Write the letter of the correct answer in the box!

Treatments	Answer
Control 9:00 a.m.	B
Drought stress 9:00 a.m.	A
Control 10:00 a.m.	C
Drought stress 10:00 a.m.	A
Control 12:00 a.m.	D
Drought stress 12:00 a.m.	B
Control 3:00 p.m.	D
Drought stress 3:00 p.m.	C

Question A1.2 Based on the average values, calculate the actual size (size in real life) of the stomatal pores in control and drought-stressed plants at 9:00 a.m. and 3:00 p.m.!

(4 points)

Treatments	Means (µm)
Control 9:00 a.m.	8.43
Drought stress 9:00 a.m.	8.1
Control 3:00 p.m.	9.86
Drought stress 3:00 p.m.	4.3

Question A1.3 Calculate how much did the stomatal pore size change under 6 hours as an effect of drought stress! Provide the answer in µm!

(2 points)

Result (µm)
3.8

Question A1.4 Calculate the stomatal opening of drought-stressed plants at 3:00 p.m. to the control at 3:00 p.m.! Provide the answer in percentage (control plants are 100% open)!

(2 points)

Result (%)
43.61

Question A1.5 Based on the experimental results, how is the physiological status in the leaves of drought stress-treated plants at 9:00 a.m. compared to the control?

(2 points)

Write the letter of the correct answer in the box!

A

Question A1.6 Based on the experimental data, what physiological change could be observed in the leaves of drought stress-treated plants at 3:00 p.m. compared to the control?

(3 points)

Write the letter of the correct answer in the box!

D

Question A1.7 In terms of drought stress tolerance the breeding of what types of plant species could be an aim for scientists?

(3 points)

Write the letter of the correct answer in the box!

D

Problem A2

Question A2.1 Identify the photosynthetic pigments in the control sample by numbering from top of the chromatography paper! Write the letter of the appropriate pigment to the corresponding numbers in the field:

(12 points)

Order	Pigment
1.	C
2.	D
3.	A
4.	B

Question A2.2 Measure the vertical width of each pigment streak with a ruler on the chromatographs and determine which pigments' amount altered due to the prolonged drought stress compared to the control!

(10 points)

Write the letter of the correct answer in the box!

Findings	Answer
The amount of chlorophyll *b* in the drought stress-treated plants compared to the control:	B
The amount of chlorophyll *a* upon stress compared to the control:	B
The ratio of chlorophyll *a/b* as a result of prolonged drought stress:	B
The amount of carotene in the drought stress-treated plants compared to the control:	B
The amount of xanthophylls as a result of prolonged drought stress compared to the control:	B

Question A2.3 Based on the experimental results, what physiological alteration could be detected in the leaves of drought stress-treated plants at 3:00 p.m.?

(6 points)

Write the letter of the correct answer in the box!

C

Question A2.4 In terms of drought stress tolerance the sublimation of what types of plant species could be an aim for breeders?

(4 points)

Write the letter of the correct answer in the box!

C

Problem A3

Question A3.1 Calculate how much absolute ethanol (100%) and distilled water will you need for the solution!

(4 points)

Write the letter of the correct answer in the box!

B

Question A3.2 Calculate how much 80% ethanol and proline stock solution will you need!

(9 points)

Write the letter of the correct answer in the box!

C

Question A3.3 Determine the color reaction of proline on the isatin test paper!

(8 points)

Write the letter of the correct answer in the box!

D

Question A3.4 Calculate the proline concentration of the dilution!

(4 points)

Write the letter of the correct answer in the box!

C

Question A3.5 Determine the color reaction of the extracts of plant samples on the isatin test paper!

(4 points)

Write the letter of the correct answer in the box!

B

Question A3.6 Calculate the proline concentration in the plant samples! Use the previous calibration (A3.4. and A3.5.)!

(3 points)

Write the letter of the correct answer in the box!

B

Question A3.7 What could be the purpose of proline detection?

(4 points)

Write the letter of the correct answer in the box!

D

Problem B

B.1 Standardization of potassium permanganate (titrant) solution

Question B.1.1 In what ratio do permanganate and oxalate ions react? Supplement the following stoichiometric equation with the missing stoichiometric numbers! Write the number values directly into the small boxes! [*4 points*]

2	MnO_4^- +	5	$(COO)_2^{2-}$ +	16	H^+ =	2	Mn^{2+} +	10	CO_2 +	8	H_2O

Note: simple ions that do not change chemically are not indicated in the equation (e.g. K^+, Cl^-).

Question B.1.2 Calculate the molecular weight of sodium oxalate (OX). Write your result in the small box below (left)! Use the following relative atomic masses for your calculations: Ar(H) = 1.01; Ar(C) = 12.01; Ar(O) = 16.00; Ar(Na) = 22.99.
Calculate the mass of OX needed to prepare 500 mL solution of 0.0480 M concentration, by the precision of three decimals (planned value, right box). [*4 points*]

M_r ($Na_2(COO)_2$) = 134.00 ; m ($Na_2(COO)_2$), plan = 3.216 g

Question B.1.3 Note the mass value that was actually measured by balance (left box). Use it to calculate the concentration of OX solution; fill in the right box with 4 decimals precision. [*4 points*]

m ($Na_2(COO)_2$), meas = ____ g; c ($Na_2(COO)_2$ = ____ $\frac{mol}{L}$

Question B.1.4 Write down your titration results and calculate the exact concentration of the $KMnO_4$ solution ("$c_{titrant}$")). Add the parallel End-point volumes (at least V_1 and V_2, with 2 decimals) and calculate c_{KMnO4} (with 4 decimals) using the stoichiometry consideration in **B.1.1**. Fill in all blue boxes! For detailed calculation do not use this box, only indicate the end results! [*10 points*]

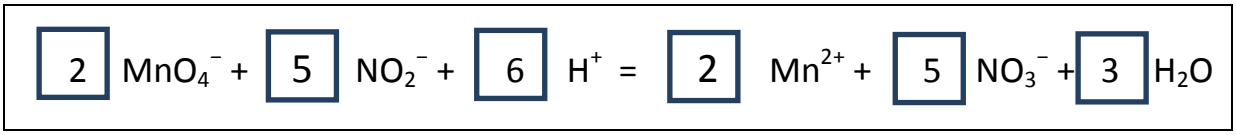
V_1 = ____ *mL* *if needed:* V_3 = ____ *mL*

V_2 = ____ *mL*

$V_{average}$ = ____ *mL* $c_{titrant}$ = ____ $\frac{mol}{L}$

B.2 Determination of the exact concentration of nitrite ions in the water samples

Question B.2.1 In what ratio do permanganate and nitrite ions react? Supplement the following stoichiometric equation with the missing stoichiometric numbers! Write the number values directly into the small boxes! [*4 points*]



Question B.2.2 Write down your titration results in the fields below. Add the parallel End-point volumes (at least V_1 and V_2, with 2 decimals) and calculate the exact NO_2^- concentration of the water samples (with 4 decimals precision) collected at checkpoints #5 and #11! For detailed calculation do not use this box, only indicate the end results!

[*32 points*]

Checkpoint number: 5
Checkpoint name: Tiszalök

V_1 = _____ *mL* *if needed:* V_3 = _____ *mL*

V_2 = _____ *mL*

$V_{average}$ = _____ *mL* $c_{nitrite\ \#5}$ = _____ $\frac{mol}{L}$

Checkpoint number: 11
Checkpoint name: Öcsöd

V_1 = _____ *mL* *if needed:* V_3 = _____ *mL*

V_2 = _____ *mL*

$V_{average}$ = _____ *mL* $c_{nitrite\ \#11}$ = _____ $\frac{mol}{L}$

B.3 Location of contamination sites

Question B.3.1 Knowing the flow rates at each section of interest (checkpoints, riverside company sites), you can calculate the nitrite ion concentration difference (Δc) by which the potential polluting site contributes to the nitrite ion level in the water. This difference is the evidence that the company is releasing nitrite compounds into the environment! Which are these contamination sites? Check the fields below and supplement it with data. Locate the sites! Also, indicate the levels of pollution: Z: zero (no) pollution. L: low pollution, H: high pollution. Pollution levels are:
Zero, if Δc×w at the Company site is below 40 mol/s
Low, if Δc×w at the Company site is between 40-1000 mol/s
High, if Δc×w at the Company site is above 1000 mol/s [42 points]

Company site	$\Delta C_{nitrite}$ $\left(\frac{mol}{L}\right)$	$P = \Delta C_{nitrite} \times w$ (mol/s)	Pollution level (Z,L or H)
A - Fábiánháza Brewery	0.02	60	L
B - Hungry Cat Cheese Factory	0	0	Z
C - Zemplén Tool Factory			
D - BorsodChem	0.0412	1195	H
E - Tiszanewcity Chemicals			
F - Mátra Power Plant	0	0	Z
G - Szolnok Rail Cargo	8.83E-7	0.5	Z
H - Wild West Cowboys Dairy Farm			
I - Bihari Tobacco Fields	0.018	270	L
J - Szeghalom Thermoelectrics Ltd	0.012	180	L
K - Mezőberény Croplands	0	0	Z
L - Kunszentmárton Pig Farm			
M - Treeclimbing Goat Pastures	0.045	45	L
N - Makó Rubber Factory	3.533E-5	5.3	Z

Question C1.1a-b Read the x and y distances of the markings from the bottom corner of the frame, calculate the angle α of the slope to the horizontal, and write the values in the appropriate lines of the table. *(3 points)*

x	y	α
range: 10 … 16 cm	range: 9 … 11 cm	numerical value of $\arctan\frac{y}{x}$
range: 7 … 16 cm	range: 9 … 11 cm	numerical value of $\arctan\frac{y}{x}$

Question C1.2a-b Write your results in the appropriate lines of the table. *(9 points)*

n	d_1 (mm)	d_2 (mm)	d_3 (mm)	d_4 (mm)	d_5 (mm)	d_6 (mm)	d_7 (mm)	d_8 (mm)	d_9 (mm)	d_{avr} (mm)
3 … 9	2 … 8 mm	…	…	…	n result					correct numerical value of
…	…									the avarage:
…	…									$\frac{1}{n}\sum_{1}^{n} d_i$

Question C1.3a-e Write your readings in appropriate boxes of the table.

Question C1.3f Calculate the average values in every column and write your results in the appropriate boxes of the last line in the table. *(12 points)*

h (cm)	1	2	3	4	5	6	7	8	9	10	↑	↓	W
m_1 (g)	3.5	5.0	6.6	7.9	9.3	10.2	10.9	11.5	12.0	12.8	6.0	63.3	38.3
m_2 (g)	can vary in a wide range (-50% … +150%)										±1.0	-20 … +40	±1.0
m_3 (g)													
m_{avr} (g)	well calculated averages: $\frac{1}{3}\sum_{1}^{3} m_i$												

Question C1.4a Write your readings in the first 10 empty boxes (1 – 10) of the table.

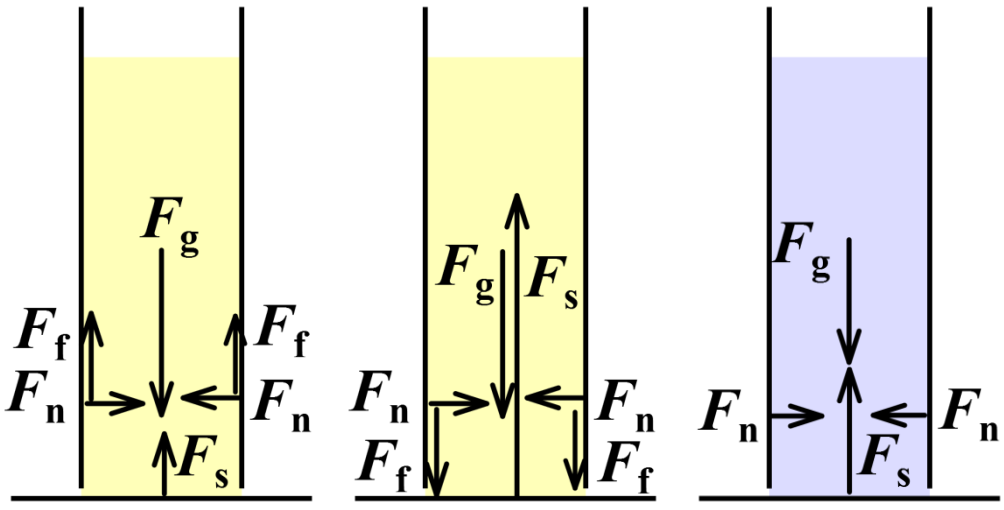
Question C1.4b Write the value shown on the scale in the box 'W' in the table. *(4 points)*

h (cm)	1	2	3	4	5	6	7	8	9	10	W
m_w (g)	0.9 -0.5 +1.5	3.4 ±1.5	5.5 ±1.5	8.2 ±1.5	9.8 ±1.5	12.2 ±2.0	14.4 ±2.0	17 ±2.0	19.2 ±2.0	21.5 ±2.0	23.6 ±1.0

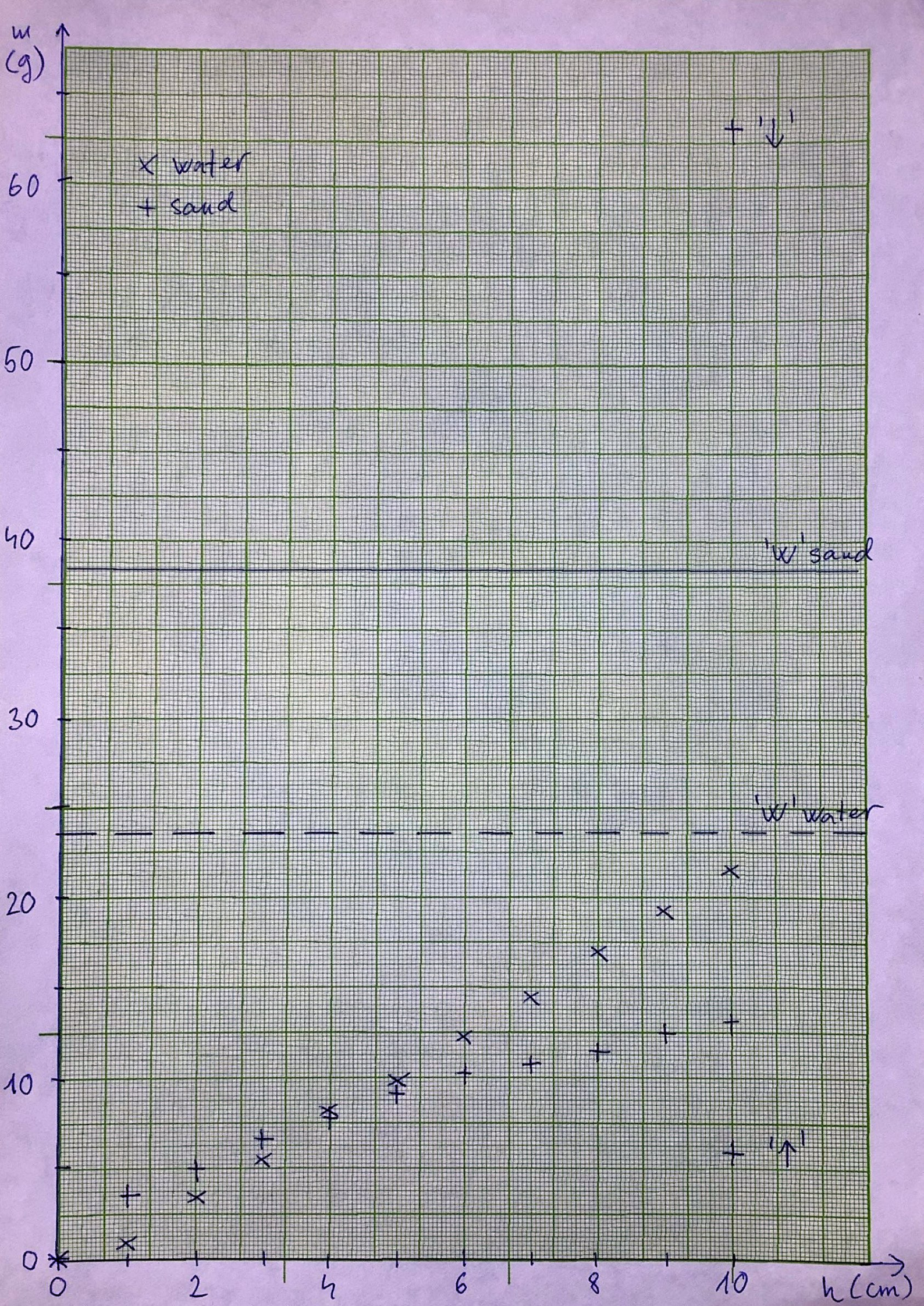
Question C1.5 Plot **in the same graph** on a *graph paper*, labeled as '*graph C1.5'*, the calculated average values m_{avr} for the yellow sand (the first 10 boxes of the last line in table **C1.3a-e** on the *Answer sheet*) and the measured values m_w for water (the first 10 data in table **C1.4a-b** on the *Answer sheet*) in the function of the material level h.
Draw a horizontal line in both cases at the value corresponding to the total weight of the material in the tube (column 'W').
For yellow sand, mark both the minimum and maximum average values (columns ↑ and ↓ of the last line in table **C1.3a-e** on the *Answer sheet*) at $h = 10$ cm. *(6 points)*

Do not forget to attach '*graph C1.5*' to the answer sheet!

Question C1.6 Draw the forces acting on the sand in the sketches. On the left side at the moment when the value, shown on the scale was minimal (**C1.3b** ↑), and on the right side at the moment when the value was maximal (**C1.3c** ↓). Use names F_g, F_s, F_n, and F_f. Note the direction of the force, and try to express its relative magnitude by the length of the arrow.
(6 points)



case **(a)**: **C1.3b** '↑' case **(b)**: **C1.3c** '↓' case **(c)**: **C1.4a** '10'


w (g)
× water
+ sand
'↓'
'W' sand
'W' water
'↑'
0
10
20
30
40
50
60
0
2
4
6
8
10
h (cm)

Question C1.7a-e Write the values in the proper boxes of the table. *(3 points)*

m_e (g)	m_w (g)		m_{ds} (g)	m_{ws} (g)	V (cm^3)	m_s (g)	V_{wa} (cm^3)	V_s (cm^3)	ρ_{avr} (g/cm^3)	ρ (g/cm^3)
8.37 ±0.03	33.75 ±0.2	yellow sand	48.25 ±0.5	57.56 ±0.5	25.38	39.88	9.31	16.07	1.57 ±0.05	2.48≈2.5 ±0.2
		black sand	47.60 ±0.5	59.81 ±0.5	25.38	39.23	12.21	13.17	1.55 ±0.05	2.98≈3.0 ±0.2

Question C1.7f Derive expressions for calculating the average density ρ_{avr} of the granulate and the density ρ of the material of the grains. Use **only** the measured quantities m_e, m_w, m_{ds}, m_{ws}, and the known density ρ_w of water. Write the steps of the derivation and the derived expressions in the next boxes. *(3 points)*

$V = \frac{m_w - m_e}{\rho_w}$, V is the volume of the sample holder

$m_s = m_{ds} - m_e$, m_s is the mass of the sand

$\rho_{avr} = \frac{m_s}{V} = \frac{m_{ds} - m_e}{m_w - m_e}\rho_w$

$$\rho_{avr} = \frac{m_{ds} - m_e}{m_w - m_e}\rho_w$$

$V_{wa} = \frac{m_{ws} - m_{ds}}{\rho_w}$, V_{wa} is the volume of the water added and it is equal to the voleme of the "cavities" between the particles

$V_s = V - V_{wa} = \frac{m_w + m_{ds} - m_e - m_{ws}}{\rho_w}$, V_s is the total volume of the sand particles

$\rho = \frac{m_s}{V_s} = \frac{m_{ds} - m_e}{m_w + m_{ds} - m_e - m_{ws}}\rho_w$

$$\rho = \frac{m_{ds} - m_e}{m_w + m_{ds} - m_e - m_{ws}}\rho_w$$

Question C1.7g Calculate the numerical values of the average density ρ_{avr} and density ρ for both yellow and black sand samples. Use $\rho_w = 1\ \mathrm{g/cm^3}$ for the density of water. Write the numerical results in the appropriate boxes of table **C1.7a-e** above. You can use the empty columns for calculations. *(4 points)*

Question C2.1a Supposing that the particle absolutely shadows the rays illuminate its cross-section, express the ΔI_1 power by the given parameters. write the expression in the box. *(4 points)*

ratio of light powers: $\frac{\Delta I_1}{I_0} = \frac{R^2\pi}{\frac{d^2}{4}\pi} = \frac{4R^2}{d^2}$

$$\Delta I_1 = \frac{4R^2}{d^2} I_0$$

Question C2.1b Express the C_R as a function of ΔI and R using the given parameters. Write the expression in the box. *(6 points)*

$\Delta I = N\Delta I_1$ *where N is the number of the particles.* $N = \frac{\Delta I}{\Delta I_1} = \frac{d^2}{4R^2}\frac{\Delta I}{I_0}$

The sum of the mass of the particles in the beam: $m_R = \frac{4}{3}R^3\pi N\rho_S = \frac{Rd^2\rho_S}{3}\frac{\Delta I}{I_0}$

Volume of the suspension illuminated by the beam: $V = \frac{d^2}{4}\pi L$

Concentration: $C_R = \frac{m_R}{V} = \frac{\frac{Rd^2\rho_S\Delta I}{3\ I_0}}{\frac{d^2}{4}\pi L} = \frac{4R\rho_S}{3L}\frac{\Delta I}{I_0}$

$$C_R = \frac{m_R}{V} = \frac{\frac{Rd^2\rho_S}{3}\frac{\Delta I}{I_0}}{\frac{d^2}{4}\pi L} = \frac{4R\rho_S}{3L}\frac{\Delta I}{I_0}$$

Question C2.2a Write the equation of the equilibrium of the forces act on a sinking particle. Derive a formula to determine the velocity as the function of the radius R using the given parameters. *(6 points)*

Equilibrium of the forces: $F_g - F_b - F_d = 0$

$$\frac{4}{3}R^3\pi g(\rho_S - \rho_w) = 6\pi\eta R v$$

$$v = \frac{2R^2(\rho_S - \rho_w)g}{9\eta}$$

Question C2.2b Evaluate numerically the time points corresponding to the given particle sizes R_i. Use the formulas derived in question **C2.2a** Evaluate them in the case of $h = 53\ mm$ and $h = 102\ mm$. Fill the table with the time results.

Question C2.2c Use the diagram of Fig.5. Read the transmitted light power values I_i.corresponding to the determined time data of **C2.2b**. Write these power data into the table. *(9+5,4 points)*

i	R_i [µm]	$h = 53$ mm		$h = 102$ mm	
		t_i [s]	I_i [mW]	t_i [s]	I_i [mW]
1	10	121.6	1.64	233.9	1.64
2	15	54.0	1.55	104.0	1.55
3	20	30.4	1.39	58.5	1.40
4	25	19.4	1.25	37.4	1.24
5	30	13.5	1.09	26.0	1.07
6	35	9.9	0.90	19.1	0.90
7	40	7.6	0.78	14.6	0.79
8	45	6.0	0.69	11.6	0.69
9	50	4.9	0.62	9.4	0.58

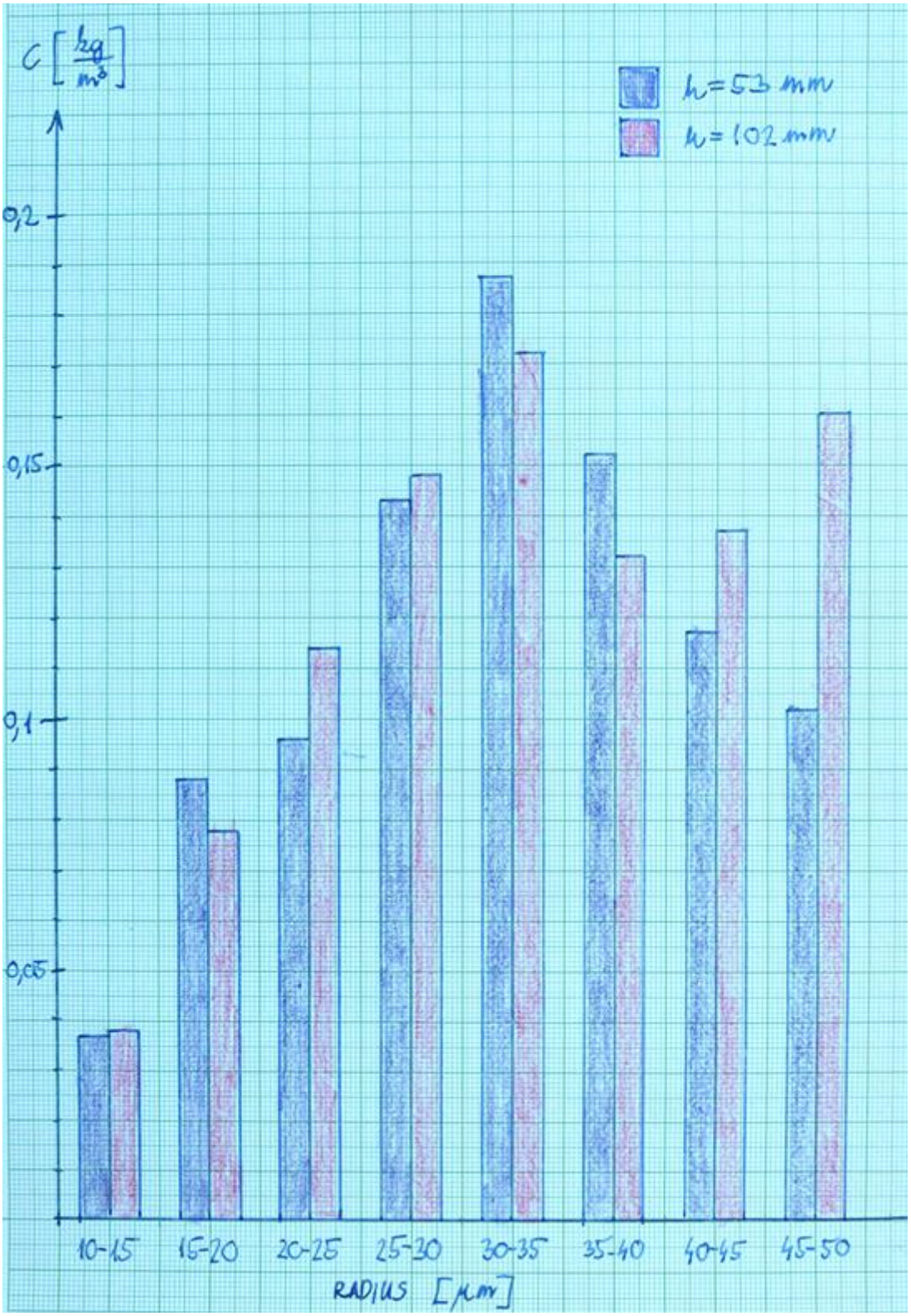
Question C2.2d Calculate the transmitted light power enhancements, and fill the table.

Question C2.2e Calculate the mass concentrations C_i corresponding to the given radius ranges, and fill the table. *(4.8+9.6 points)*

i	Range [µm]	Average radius [µm]	$h = 53$ mm		$h = 102$ mm	
			ΔI_i [mW]	C_i [kg / m^3]	ΔI_i [mW]	C_i [kg / m^3]
1	$10 < R < 15$	12.5	0.09	0.037	0.10	0.038
2	$15 < R < 20$	17.5	0.16	0.088	0.14	0.078
3	$20 < R < 25$	22.5	0.14	0.096	0.16	0.114
4	$25 < R < 30$	27.5	0.17	0.143	0.17	0.148
5	$30 < R < 35$	32.5	0.18	0.187	0.17	0.172
6	$35 < R < 40$	37.5	0.13	0.152	0.11	0.132
7	$40 < R < 45$	42.5	0.09	0.117	0.10	0.138
8	$45 < R < 50$	47.5	0.07	0.102	0.11	0.160

Question C2.2f Make bar histograms to summarize the evaluated size distribution of the suspension. Use a graph paper and label it '*graph C2.2*'. Plot simultaneously both data derived from the measurements at laser position $h = 53$ mm and $h = 102$ mm. Indicate on the graph which column belongs to which measurement. *(5.2 points)*

Do not forget to attach '*graph C2.2*' to the answer sheet!


C [kg/m³]
h=53 mm
h=102 mm
0,2
0,15
0,1
0,05
10-15
15-20
20-25
25-30
30-35
35-40
40-45
45-50
RADIUS [μm]