Country ______________________

Task 2

Marking schem

Smart cucumber

Students______________________

____

____

Problem 1 - Water hardness (31 p)

1.1.1. *Write chemical reactions occurring during the EDTA standardization:*

Reactions	*Marks*
$Mg^{2+} + H_2Y^{2-} + 2\ NH_3 \rightarrow MgY^{2-} + 2\ NH_4^+$ $MgEr^- + H_2Y^{2-} + NH_3 \rightarrow MgY^{2-} + HEr^{2-} + NH_4^+$ *1 p – reaction of Mg with EDTA* *1 p – reaction of MgEr⁻ with EDTA* *Alternatives f.ex. H+ instead of NH4+ accepted* *Alternative forms of EDTA are accepted*	2

1.1.2. *Write the volumes of EDTA solutions you used for each titration. Circle the ones you will use for calculation (4 p)*

Volume of EDTA solution, ml	*Marks*
1.1.2. *Replace fully:* *3 p – Volume falls between 23 mL and 30 mL.* *-1 p if more or less is given, or if the voulmes are in whole mililiters or only one volume is given.* *1 p – chosen volumes do not differ by more than 0.10 mL*	4

1.1.3. *Calculate exact concentration of your EDTA solution. Show your calculation. (3 p)*

Copy the exact magnesium sulfate standard solution concentration from task: __________ mol/L

Calculations:	*Marks*
1 p – correct equation used using average volume of EDTA from titration *1 p – equimolar ratio used* ***1.1.3.*** *Add:* *For the concentration 1 point if correct based on the reported volume and in correct units.*	*2*
c_{EDTA} = ___________ ***mmol/L***	*1*
Total	*3*

1.2. Determination of water hardness

1.2.1. *Write the chemical reactions occurring during the Step 4 of the determination of water hardness in the answer sheet. (2 p)*

Reactions	*Marks*
$Mg^{2+} + H_2Y^{2-} + 2\ NH_3 \rightarrow MgY^{2-} + 2\ NH_4^+$ $Ca^{2+} + H_2Y^{2-} + 2\ NH_3 \rightarrow CaY^{2-} + 2\ NH_4^+$ $MgEr^- + H_2Y^{2-} + NH_3 \rightarrow MgY^{2-} + HEr^{2-} + NH_4^+$ *1 p – reaction of Ca and Mg with EDTA* *1 p – reaction of* $MgEr^-$ *with EDTA* *Alternative forms of EDTA are accepted*	2

1.2.2. *Write the volumes of EDTA solutions you used for each titration. Circle the ones you will use for calculation (4 p)*

Volume of EDTA solution, ml	*Marks*

1.2.2. *Replace fully:* *4 p – If the obtained volume falls between 7 and 13 mL resulting in water hardness of 1.4 – 2.8 mmol/L.*	*4*

***1.2.3**. Calculation of water hardness (3 p)*

Calculations:	*Marks*
1 p – correct calculation volume of EDTA used *1 p – equimolar ratio used* ***1.2.3.** Add:* *For the concentration 1 point if correct based on the reported volume and in correct units.*	*2*
$c_{hardness}$ = ____________ ***mmol/L***	*1*
Total	*3*

***1.2.4.** Classify your water sample according to the water hardness by placing an X in the correct assessment (1p)*

Water hardness		Marks
Soft		1
Moderately hard		
Hard		
Very hard		

1 p if the classification corresponds to the result in 1.2.3.

1.3. Determination of calcium ion concentration

1.3.1. *Write down the chemical reactions occurring during steps 2 and 4 in the determination of the calcium ion concentration. (3 p)*

Reactions	*Marks*
$Mg^{2+} + 2\ OH^- \rightarrow Mg(OH)_2$ $Ca^{2+} + H_2Y^{2-} + 2\ OH^- \rightarrow CaY^{2-} + 2\ H_2O$ $CaMX^+ + H_2Y^{2-} + 2\ OH^- \rightarrow CaY^{2-} + MX^- + 2\ H_2O$ *Alternatives f.ex. Y4- instead of H2Y- accepted*	3

1.3.2. *Write the volumes of EDTA solutions you used for each titration. Circle the ones you will use for calculation (4 p)*

Volume of EDTA solution, ml	*Marks*

1.3.2. Replace fully: *4 p – If the obtained volume is by 2-4 mL lower that that obtained in the determination of water hardness.*	*4*

1.3.3. *Calculation of Ca ion concentration (3 p)*

Calculations:	*Marks*
1 p – correct calculation volume of EDTA used *1 p – equimolar ratio used* ***1.3.3.*** *Add:* *For the concentration 1 point if correct based on the reported volume and in correct units.*	*2*
c(Ca^{2+}) = ___________ mmol/L	*1*
Total	*3*

1.4. Calculation of magnesium ion concentration

1.4.1.*Show your calculation and final result (2 p)*

Calculations:	*Marks*
1 p – correct equation used ***1.4.1.*** *Add:* *For the concentration 1 point if correct based on the reported water hardness and calcium concentration.*	*1*
c(Mg^{2+}) = ___________ mmol/L	*1*
Total	2

Problem 2 Preparation of hydroponics feeding solution (42 p)

2.1.1. *Use the composition information of the fertilizer and write down what ions will be present in the fertilizer solution, if it consists only of part of the given salts and can be fully dissolved in the water! (4 p)*

	Mass fraction, %	Ion	Marks
N	10	NO_3^-	4
N	5	NH_4^+	
P_2O_5	8	HPO_4^{2-}	
K_2O	24	K^+	
MgO	3.0	Mg^{2+}	

The information about composition already specifies that nitrogen should be provided in a form of nitrate and ammonium. (1 point for correct distinction)

Phosphorus could be added in a form of phosphate or hydrogen phosphate, but use of the former will lead to precipitation of magnesium phosphate (also calcium phosphate), so hydrogenphosphate is selected.

1 op – providing a correct ion for phosphorus (PO_4^{3-} or HPO_4^{2-})

1 op – selection of HPO_4^{2-} as phosphorus containing ion because of the solubility

Metals will be in the form of metal ions.

1 op – providing K^+ and Mg^{2+} as metallic ions

THIS IS GIVEN AFTER COLLECTION OF 2.1.1. answer

2.1.2. *Calculate the mass fraction of each ion and use the charge balance to determine what other ion has to be present. (7 p)*

Feel free to use the extra columns for notes, other quantities or intermediate results.

You may use different methods of calculating the mass of salts. Show you calculation on a separate coloured sheet labelling it 2.1.2 and writing your country and team number. Table below can be skipped then.

	Mass fraction, %	Ion	Mass fraction, %	M(given form) g/mol	M(ion) g/mol	z	Marks
N	10	**NO_3^-**	44.29	14.0	62.0	1	1
N	5	**NH_4^+**	6.43	14.0	18.0	1	1
P_2O_5	8	**HPO_4^{2-}**	10.82	142.0	96.0	2	1
K_2O	24	**K^+**	19.92	94.2	39.1	2	1
MgO	3.0	**Mg^{2+}**	1.81	40.3	24.3	1	1
		Cl^-					2
Total							7

The weight fraction of the ion is calculated as:

$$w_{\text{ion}} = \frac{w_{\text{given form}} \cdot M_{\text{ion}} \cdot z}{M_{\text{given form}}}$$

Where *z* is the number of ions forming from the compound in the given form.

1 p every correct w%

c. It can be calculated, that the amount multiplied by ion charge for anions is:

1·44.29/62.0 + 2·10.82/96.0 = 0.9398 mol and for cations:

1·6.43/18.0 + 1·19.92/39.1 + 2·1.81/24.3 = 1.0157 mol

It can be deduced that an anion is required, and only chloride could be used, as carbonate will form insoluble compounds with calcium and magnesium.

1 p – stating that another anion is required

1 p – selection of Cl^- because of solubility issues with other ions

2.2. Calculation of the composition of the fertilizer

2.2.1. *In the answer sheet indicate which salts you will use by circling the correct ones. (5 p)*

KCl, KNO_3, K_2CO_3, $Na_2CO_3 \cdot 10H_2O$, $CaCl_2 \cdot 2H_2O$, $Mg(NO_3)_2 \cdot 6H_2O$, $MgCl_2 \cdot 6H_2O$, K_3PO_4, $K_2HPO_4 \cdot 3H_2O$, $Na_3PO_4 \cdot 12H_2O$, $Na_2HPO_4 \cdot 6H_2O$, NH_4NO_3, NH_4Cl.

Marks for selected salts	5

Considering the available salts and the indication that the number of salts and introduced extra ions should be as low as possible, we will select salts given below. Salts with both ions required are primarily selected. Phosphates and carbonates are not selected because this would introduce precipitation of calcium and magnesium phosphates and carbonates.

- NH_4NO_3 for NH_4^+ (we will check later that this introduce all the required NH_4^+ but not all the NO_3^-) – 1 op for the selection and calculations
- $Mg(NO_3)_2$ for Mg^{2+} (we will check later that this introduce all the required Mg^{2+} but still not all the NO_3^-). – 1 op for the selection and calculations
- K_2HPO_4 for HPO_4^{2-} (we will check later that this introduce all the required HPO_4^{2-} but not all the K^+) – 1 op for the selection and calculations
- KNO_3 for the remaining NO_3^- (we will check later that this does not introduce all the required K^+) – 1 op for the selection and calculations
- KCl for the remaining K^+ – 1 op for the selection and calculations

Let's calculate the amount of ions required. For this let's assume that we have 100 g of fertiliser. The weight fractions and therefore the mass of most of the ions already was calculated in the previous point.

The amount is calculated as n = m/M

We can conclude that we should have NH_4NO_3 in the amount as calculated for NH_4^+, $Mg(NO_3)_2$ as calculated for Mg^{2+} and K_2HPO_4 as calculated for HPO_4^{2-}.

As the introduced NH_4NO_3 and $Mg(NO_3)_2$ does not provide the required NO_3^- amount, we calculate the amount of required NO_3^- and therefore KNO_3 as:

$n(KNO_3) = n(NO_3^-) - n(NH_4NO_3) - 2 \cdot n(Mg(NO_3)_2) = 0.7144 - 0.3572 - 2 \cdot 0.0745 = 0.2082$ mol

As the introduced K_2HPO_4 and KNO_3 does not provide the required K^+ amount, we calculate the amount of required K^+ and therefore KCl as:

$n(KCl) = n(K^+) - n(KNO_3) - 2 \cdot n(K_2HPO_4) = 0.5095 - 0.2082 - 2 \cdot 0.1127 = 0.0759$ mol

Ion	m / g	M(ion) g/mol	n / mol	
NO_3^-	44.29	62.0	0.7144	$=n(NH_4NO_3) + 2 \cdot n(Mg(NO_3)_2) + n(KNO_3)$
NH_4^+	6.43	18.0	0.3572	$=n(NH_4NO_3)$
HPO_4^{2-}	10.82	96.0	0.1127	$=n(K_2HPO_4)$
K^+	19.92	39.1	0.5095	$n(KNO_3) + 2 \cdot n(K_2HPO_4) + n(KCl)$
Mg^{2+}	1.81	24.3	0.0745	$=n(Mg(NO_3)_2)$

The mass of each compound is calculated as:

Use the calculated amount of salts and calculate its mass. Take into account that some of the salts are hydrates. As we have 100 g of sample, the calculated mass is equal to the weight fraction of salts in the fertiliser.

Alternative selection of salts: KCl, KNO_3, K_2CO_3, $Na_2CO_3 \cdot H_2O$, $CaCl_2 \cdot 2H_2O$, $Mg(NO_3)_2 \cdot 6H_2O$, $MgCl_2 \cdot 6H_2O$, K_3PO_4, $K_2HPO_4 \cdot 3H_2O$, $Na_3PO_4 \cdot 12H_2O$, $Na_2HPO_4 \cdot 6H_2O$, NH_4NO_3, NH_4Cl - full 5 points

Alternative selection of salts 2: KCl, KNO_3, K_2CO_3, $Na_2CO_3 \cdot H_2O$, $CaCl_2 \cdot 2H_2O$, $Mg(NO_3)_2 \cdot 6H_2O$, $MgCl_2 \cdot 6H_2O$, K_3PO_4, $K_2HPO_4 \cdot 3H_2O$, $Na_3PO_4 \cdot 12H_2O$, $Na_2HPO_4 \cdot 6H_2O$, NH_4NO_3, NH_4Cl. - 4 points awarded, as the sum of the mass in next point is larger than 100%.

2.2.2. *In the answer sheet indicate mass of each salt you need to create 100g of fertiliser salt mix (10 p)*

Feel free to use the extra columns for notes, other quantities or intermediate results

Compound	$m_{(100\ g\ fertiliser)}$, g	w, %	n, mol	M, g/mol	Marks
NH_4NO_3	28.58	28.58	0.3572	80.0	2
$Mg(NO_3)_2 \cdot 6H_2O$	19.09	19.09	0.0745	256.3	2
$K_2HPO_4 \cdot 3H_2O$	25.72	25.72	0.1127	228.2	2
KNO_3	21.05	21.05	0.2082	101.1	2
KCl	5.66	5.66	0.0759	74.6	2
Sum	100.1				
Total					10

2 p each correct end result

We can sum the weight fraction for all the salts and see that no other component is required.

If 2.1.2. empty, but all amounts correctly calculated, and submitted calculation make sense, 7 full points for 2.1.2. Task

Alternative compositon (full 10 points awarded):

Salt	n, mol	M	m / g
NH4NO3	0.3572	80	28.58
MgCl2*6H2O	0.03795	203.3	7.72
K2HPO4*3H2O	0.1127	228.2	25.72
KNO3	0.2841	101.1	28.72
Mg(NO3)2*6H2O	0.03655	256.3	9.37
		sum	100.11

Alternative compositon 2 (full 10 points awarded):

Salt	n, mol	M	m / g
NH4NO3	0.2813	80	22.5
Mg(NO3)2*6H2O	0.0745	256.3	19.09
K2HPO4*3H2O	0.1127	228.2	25.72
KNO3	0.2841	101.1	28.72
NH4Cl	0.0759	74.6	5.66
		sum	101.69

2.3. Preparation of the feeding solution

2.3.1. *Indicate the mass of each salt that you have weighted (1p)*

Compound	M per 1 g fertilizer, g	Marks
NH_4NO_3	0.29	1
$Mg(NO_3)_2\cdot6H_2O$	0.19	
$K_2HPO_4\cdot3H_2O$	0.26	
KNO_3	0.21	
KCl	0.06	

1p for dividing answer from 2.2.2. with 100 and rounding up to weightable result

0.5 if one of the masses is not correct.

0 points if more than one incorrect mass given.

2.3.2. *Label the flask and tube. The lab assistant after completion of work will measure conductivity of the sample to assess the quality of your work. (6 p)*

Filled out by lab assistant

Solution exists and is correctly poured in the volumetric flask	Marks: 1
Weight of remaining salt ___________	Marks: 2
Sediments ______	Marks: 1
Conductivity ____________	Marks: 2
Total	6

2 points if weight of the remaining salt is between 0.7 and 0.9 g.

1 point if solid non sticky powdered sample provided.

1 points if no sediments present.

2 points if conductivity between 3200 and 4000 uS/cm.

1 point if conductivity between 1000 and 10 000 uS/cm.

2.4. Impact of water hardness

2.4.1. *Enter your calculated concentration of Mg^{2+} (1 p)*

Concentration, mmol/L	Answer	Marks
Mg^{2+}	1.49	1

As the feeding solution is prepared by dissolving 2.0 g of fertilizer in 1.0 L of water, the concentration of ions is calculated as:

$$c = \frac{n}{V} = \frac{n_{100\,\mathrm{g}}}{50 \cdot 1.00} = \frac{n_{100\,\mathrm{g}}}{50}$$

2.4.2. *In the answer sheet complete the table by writing the ion amounts in the feeding solution, if adjustment is needed and adjusted amounts (1 p).*

Ion	n, mmol	Adjustment, mmol	n(adj.), mmol	Marks
Mg^{2+}	1.490	–0.3	1.190	1

1 point if the adjusted value is smaller by the given difference.

2.4.3. *Mark the salts (with Y/N) the mass of which have to be changed to prepare a salt mix for feeding solution made in groundwater. If changes, write Y, if not N (5 p)*

Compound	Mass changes needed if groundwater used (Y/N)	Marks
NH_4NO_3	N	1
$Mg(NO_3)_2$	Y	1
K_2HPO_4	N	1
KNO_3	Y	1
KCl	Y	1
Total		5

Although only magnesium concentration should be adjusted, as can be seen from the calculations above, adding less magnesium nitrate will result in changing the mass of KNO_3 to provide the required amount of nitrates. This, however, will affect the mass of KCl which has to be added, to provide the required amount of potassium.

2.4.4. *Write down the chemical formula of the compound formation of which does not allow to use the groundwater for preparation of the feeding solution (2 p)*

Chemical formula	Marks
$CaHPO_4$	2

Problem 3 Water transport in plants

3.1. *Write down the letter (letters) that correspond to the correct terms in each blank. (8 p)*

Blank No	*Letter*	*Blank No*	*Letter*	*Marks*
1	*p and h*	*9*	*h*	*1*
2	*o and g*	*10*	*m*	*1*
3	*p*	*11*	*d*	*1*
4	*h*	*12*	*l*	*1*
5	*c*	*13*	*f*	*1*
6	*k*	*14*	*p*	*1*
7	*e*	*15*	*h*	*1*
8	*p*	*16*	*a*	*1*
Total marks				

0.5 p each correct box

Vascular tissues in plants are composed of two types of tissues, 1.[Xylem p and Phloem h], which are responsible for the transport of 2. [Water o and Nutrients g] throughout the plant. These tissues are organized into structures called vascular bundles which are found in various parts of the plant such as roots, stems, and leaves. 3.[Xylem p] tissue transports water and minerals from the roots to the rest of the plant, while 4. [Phloem h] tissue transports organic compounds such as sugars and amino acids to where they are needed.

The structure of vascular bundles can vary depending on the type of plant and the environmental conditions. In 5.[Dicot c] plants, vascular bundles are typically arranged in a 6.[Ring k] around the stem or root, while in 7. [Monocot e] plants vascular bundles are scattered throughout the stem. Within each vascular bundle, the 8. [Xylem p] tissue is typically located towards the centre of the bundle, while the 9[Phloem h] tissue is located towards the periphery.

The movement of water and minerals through the xylem tissue is driven by a process called 10. [transpiration m], which involves the 11.[evaporation d] of water from the leaves through 12.[stomata l]. This creates a 13. [negative pressure f] that pulls water and minerals up from the roots and through the 14. [Xylem p] tissue. The flow of organic compounds through the 15.[Phloem h] tissue, on the other hand, is driven by a process called pressure flow, which involves the 16.[active transport a] of sugars and other compounds from source to sink tissues (areas of active growth (apical and lateral meristems, developing leaves, flowers, seeds, and fruits) or areas of sugar storage (roots, tubers, and bulbs).

3.2.1. *Call the lab assistant to evaluate your selection (1)*

Filled out by lab assistant

Marks for quality _______	Signature	Marks: 1

1 p if chosen section is uniform and at least half of cross section is represented, selected piece is not a wedge

3.2.2. *Scientific drawing of a vascular bundle (8 p)* For this task you can skip adding title and for labelling use letters from task 3.1.

Drawing	*Marks*
5 p according to the criteria in task sheets *Pencil,* *Clear lines* *Shape of cells corresponds to real* *Has labels (letters)* *Has magnification* *3p for correct labels - xylem, phloem, vascular bundle*	*8*

Observe the whole stem cross section. Answer questions concerning cross section. Mark the letter of the correct answer

3.2.3.

Answer (a,b,c,d)	Marks
d	1

3.2.4.

Answer (a,b,c,d)	Marks
b	1

3.2.5.

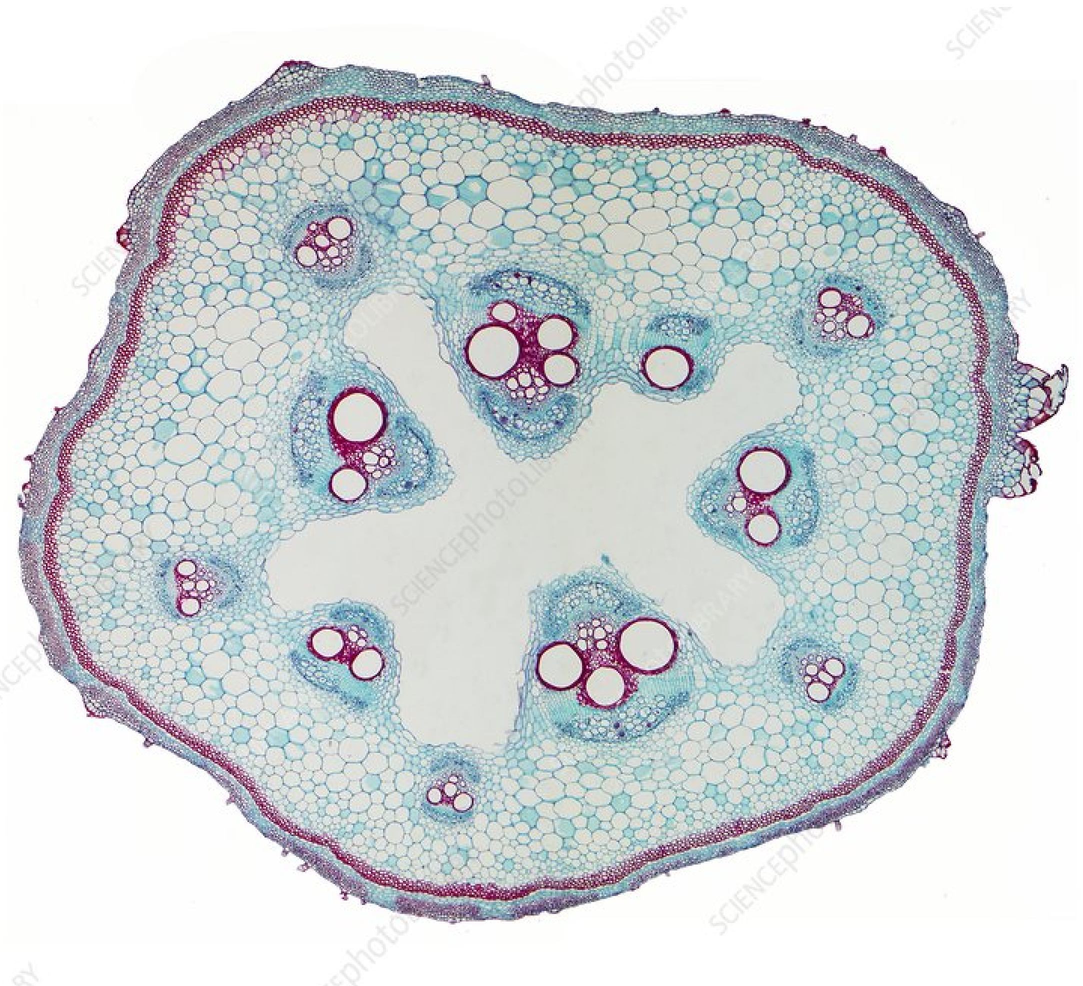
Answer (a,b,c,d)	Marks
a	1

3.2.6.

Answer (a,b,c,d)	Marks
a	1

Skills required from student: Observation of cross section, deduction from observations.

Example of cucumber stem stained with astra blue and safranin



3.2.7. *Pick correct dimension of a vascular cell diameter (2 p)*

Answer (a,b,c,d,e,f,g)	Marks
D	2

Two points as two steps are required to come to the answer

Usually diameter of cucumber xylem is in magnitude of 100 mkm

3.2.8. *Read the descriptions and mark which are applicable to the phloem (P), which to xylem (X) which to both (PX) and which to none (0) (5 p)*

Description	*Tissue (P, X, PX, 0)*	*Marks*
Move substances from roots to leaves	PX	*1, 0.5 for just P or X*
Are made from elongated, dead cells with thick cell walls that provide support and durability	X	*1*
Can contract to facilitate movement of liquid	0	*1*
Will transport molecules against concentration gradient	P	*1*
Will be tapped by aphids to obtain nourishment	P	*1*
Total marks		

Mark the letter of the correct answer

3.3.1. *Mark the letter of the correct answer (1 p)*

Answer (a,b,c,d,e,f)	Marks
b	1

3.3.2. *Write formula of height of water column in glass capillary (1 p)*

Answer	Marks
$\boxed{h \approx \frac{1.48 \times 10^{-5}\ \mathrm{m}^2}{r}.}$ *Half a point if values inserted but not solved*	1

3.3.3. Calculate the height of the water column if a student performs simulation of redwoods xylem in the lab with water and glass capillary.

Answer	Marks

98-100 cm	1

3.3.4 *Draw biological drawing of stoma from both sides of a leaf. Label opening with A, guard cells with B, and epidermal cells with C. (10 p)*

Drawing	*Marks*
Upper side of leaf Lower side of leaf *5 p according to the criteria in task sheets* *Pencil,* *Clear lines* *Shape of cells corresponds to real* *Has labels (letters)* *Has magnification* *3p for correct labels - opening, guard cells, epidermis* *2p for correct identification of leaf sides (can be distinguished by shape of epidermis cells)*	*10*

3.3.5.*Provide your measurements of stomatal number in answer sheet (6 p)*

No.	Lower surface	Upper surface	Marks
Stomata in field 1			2
Stomata in field 2			2
Stomata in field 3			2
Average stomata in field	20-50	10-40	
Total			6

2 p uper side

2p lower side

2p Lower > higher

3.3.6. *Mark the letter of the correct answer (1 p)*

Answer (a,b,c,d)	Marks
c	1

Task 4 Water demand by plants

4.1. *Call the lab assistant to evaluate your pigment extract (1p)*

Filled out by lab assistant

Marks for quality _______	Signature	Marks: 1

1 p if pigment present in the extract

4.2. *Write down measurements (4 p)*

Wavelength, nm	***A, AU***	***Marks***
		4

1 p calibration has been performed

1 p data with 20 nm inkr

2 p additional 4 measurements with 10 nm increments (1 p each peak)

4.3. *See Graph2 attached (4 p)*

Filled out by evaluator

Marks for graph _______	Marks: 4

2 p for correct axes with labels (1 p each axis)

1 p graph, according to the measurements

1 p graph takes at least 50% of the sheet

4.4. *See Graph1 and Graph2 attached (5 p)*

Filled out by evaluator

Marks for intervals marked on graph _______	Marks: 4

1 p intervals are marked on each graph

1 p intervals match between graphs

1 p interval is not smaller as measurement step (20 or 10 nm)

1p intervals are not wider than peaks

4.5. *See Graph1 attached (3 p)*

Filled out by evaluator

Marks for interval fractions written on graph ______	Marks: 3

Points calculated as percentage from all markings, rounded up to precision of 1 points.

all fractions correct 3 p

4.6. *See Graph1 attached (3 p)*

Filled out by evaluator

Marks for radiation power per square meter of each interval written on graph ______	Marks: 3

Points calculated as percentage from all markings, rounded up to precision of 1 points.

all correct 3 p

4.7. *Write down your calculated k in the answer sheet, and show your calculation (2 p)*

	Your answer	Marks
Show calculation		1
k		1
Total marks		2

1 p correct wavelength chosen, 1 p result

4.8 *Determine the normalised average absorbance for each interval of the absorption spectrum. See Graph2 attached (3 p)*

Filled out by evaluator

Marks for intervals marked on graph ______	Marks: 3

Points calculated as percentage from all markings, rounded up to precision of 1 points.

4.9. *Write down how much light is transmitted through the sample if the absorbance is 2, and show your calculation (3 p)*

	Your answer	Marks

Show calculation		2
Transmittance	*1%*	1
Total marks		3

1 p Logarithm expresed

1 p 1/T

1p result

***4.10.** Determine the absorbed energy per second (absorbed radiation power) for each wavelength interval, and show your calculation for one wavelength (3 p)*

Interval wavelengths, nm			***Absorbed energy per second***	***Marks***
				2

Calculation of absorbed energy per second for first interval	***Marks***
	1

1 p correct calculation, 2 p additionally if all calculations performed correctly

4.11. *Write down your calculated sum for total absorbed radiation power (1p)*

Total absorbed radiation power	***Marks***
	1

1 p correct total absorbed radiation power

4.12. *Write down your calculated value for required water, show calculation (2 p)*

Calculation of how much water is needed in one hour per	***Marks***

square metre of cucumber leaf	
	2

1 p seconds converted to hours, 1 p correct end result

Task 5 Exploring hydroponics

5.1. *Write down the measurements (1 p).*

	Your answer	Marks
Initial length of tubes		1

1 p for filled out field with believable length (around 3 and 1 meters)

5.2. *Write down the measurements in the table (3 p)*

	Length of tube, m	*h, m*	*Δp*	*V, ml*	*t, s*	*Marks*
Total marks						*3*

1 p data entered, 1 p delta p correctly calculated, 1p h and V not changed with shorter tube

5.3. *Choose the final setup parameters for the rest of the experiment (2 p)*

	Length of tube, m	*h, m*	*Δp*	*V, ml*	*t, s*	*Marks*
short						*2*
long						

2 p if final setup gives measurable time differences at least 5 seconds

5.4. *Show calculations and final results for Q with the final setup. (2 p)*

	Calculations	*Marks*

Q for the longest tube		2

1 p Correct formula used, 1 p correct final result

5.5. *Fill in your data in the table (4 p)*

Length of tube, m	*Δt, s*	*ΔV, ml*	*Q, ml/s*	*Marks*
				4

0.5 points for each measurement, max 4p

5.6. *Write trendline equation here (2 p)*

		Marks
Trendline equation		2

1 p trendline equation obtained, 1 p correct approximation used

5.7. *Write down your obtained n (2 p)*

		Marks

n		*2*

1 p negative value, 1 p corresponds to trendline equation

5.8. *Show calculations and write the answer. (2 p)*

	Calculations	*Marks*
Length of the tube		*2*

1 p Correct formula used, 1 p correct data from 4.12 used

Problem 6 Setting up the greenhouse.

6.1. *Mark the letter of the correct answer (1 p)*

Answer (a,b,c,d)	Marks
b	1

6.2. *Mark the letter of the correct answer (1 p)*

Answer (a,b,c,d)	Marks
b	1

6.3. *Indicate what would happen if you would plant cucumbers to have larger or smaller leaf area index. Consequences that you would observe in case of larger index mark with L and smaller S, 0 if none fits. (4 p)*

	Answer (L, S)	Marks
Leaves would receive to little of light	L	1
You would experience economic losses	L, S	2
Air in the greenhouse would be too humid	0	1
Total marks		4

6.4. *Show calculations and write the answer. (2 p)*

Calculations	*Marks*
1 p for correct assessment of cucumber leaf area (300-600 cm^2) *1 p for calculations*	*2*

6.5. *Mark the letter of the correct answer (1 p)*

Answer (a,b,c,d)	Marks
b	1

6.6. *Mark the letter of the correct answer (2 p)*

Answer (a,b,c,d)	Marks
a, b	2

6.7.

Mark the letter of the correct answer/s (1 p)

Answer (a,b,c,d)	Marks
a, b, d	1

3 correct answers selected – 1 p; 2 correct answers selected – 0,5 p