



Country _____

Task 2
Answer sheets

Smart cucumber

TEAM _____

Students _____



Problem 1 - Water hardness

1.1.1. Write chemical reactions occurring during Step 5 the EDTA standardization: (2 p)

<i>Reactions</i>	<i>Marks</i>

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

<i>Volume of EDTA solution, mL</i>	<i>Marks</i>
1. 2.	

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

Copy the exact magnesium sulfate standard solution concentration from bottle: _____
mol/L

<i>Calculations:</i>	<i>Marks</i>
<i>C_{EDTA}</i> = _____ <i>mmol/L</i>	
<i>Total</i>	

1.2. Determination of water hardness

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

<i>Reactions</i>	<i>Marks</i>

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

<i>Volume of EDTA solution, mL</i>	<i>Marks</i>
1. 2.	

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1.2.3. Calculation of water hardness (3 p)

<i>Calculations:</i>	<i>Marks</i>
Chardness = _____ mmol/L	
Total	

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		
Moderately hard		
Hard		
Very hard		

1.3. Determination of calcium ion concentration

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

Reactions	Marks

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

<i>Volume of EDTA solution, ml</i>	<i>Marks</i>
1. 2.	

1.3.3. Calculation of Ca^{2+} ion concentration (3 p)

<i>Calculations:</i>	<i>Marks</i>
$c(\text{Ca}^{2+}) = \text{_____} \text{ mmol/L}$	
Total	

1.4. Calculation of magnesium ion concentration

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

Calculations:	Marks
$c(\text{Mg}^{2+}) = \text{_____} \text{ mmol/L}$	
Total	

Problem 2 Preparation of hydroponics feeding solution

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		
N	5		
P ₂ O ₅	8		
K ₂ O	24		
MgO	3.0		

WHEN YOU HAVE FILLED OUT THIS SHEET, GIVE IT TO LAB ASSISTANT TO RECEIVE CORRECT IONS PRESENT

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 your 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, %				Marks
N	10	NO₃⁻					
N	5	NH₄⁺					
P ₂ O ₅	8	HPO₄²⁻					
K ₂ O	24	K⁺					
MgO	3.0	Mg²⁺					
Total							

2.2. Calculation of the composition of the fertilizer

2.2.1. Indicate which salts you will use by circling the correct ones. (5 p)

KCl, KNO₃, K₂CO₃, Na₂CO₃·10H₂O, CaCl₂·2H₂O, Mg(NO₃)₂·6H₂O,
MgCl₂·6H₂O,

K₃PO₄, K₂HPO₄·3H₂O, Na₃PO₄·12H₂O, Na₂HPO₄·6H₂O, NH₄NO₃, NH₄Cl

Marks for selected salts	
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2.2.2. 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				Marks
Total					

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

2.3.2. Label the flask and tube with your country code and team A or B. The lab assistant after completion of work will measure conductivity of the sample to assess the quality of your work. They will also inspect your prepared salt mix (6 p)

Filled out by lab assistant

Criteria 1	Marks:
Criteria 2	Marks:
Criteria 3	Marks:
Criteria 4	Marks:
Total	

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+}		

2.4.2. Complete the table by writing the magnesium 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+}				

2.4.3. Mark the salts (with Y/N in the table) 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
Total		

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

Problem 3 Water transport in plants

3.1. Next to the number of the blank field, write the letter(s) that correspond to the correct terms when filling in the text in the task. (8 p)

<i>Blank No</i>	<i>Letter</i>	<i>Blank No</i>	<i>Letter</i>	<i>Marks</i>
1	<i>and</i>	9		
2	<i>and</i>	10		
3		11		
4		12		
5		13		
6		14		
7		15		
8		16		
<i>Total marks</i>				

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

Filled out by lab assistant

Marks for quality _____	Signature	Marks:
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3.2.2. Scientific drawing of a vascular bundle (8 p) For this task you can skip adding title and for labeling use letters from task 3.1.

<i>Drawing</i>	<i>Marks</i>

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

3.2.3. (1 p)

Answer (a,b,c,d)	Marks

3.2.4. (1 p)

Answer (a,b,c,d)	Marks

3.2.5. (1 p)

Answer (a,b,c,d)	Marks

3.2.6. (1 p)

Answer (a,b,c,d)	Marks

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

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

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		
Are made from elongated, dead cells with thick cell walls that provide support and durability		
Can contract to facilitate movement of liquid		
Will transport molecules against concentration gradient		
Will be tapped by aphids to obtain nourishment		
Total marks		

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

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

3.3.2. Write an equation to calculate the height of the water column in a glass capillary under the given conditions. You may use the symbol of the unknown physical quantities (1 p)

Answer (equation)	Marks

3.3.3. Calculate the height of the water column if a student performs simulation in the lab with water and glass capillary with the same diameter. Give your result expressed in cm and round it as integer.(1 p)

Answer	Marks

3.3.4 Draw biological drawing of stoma and surrounding epidermal cells 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	
Total marks	

3.3.5. Provide your measurements of stomatal number. (6 p)

No.	Lower surface	Upper surface	Marks
Stomata in field 1			
Stomata in field 2			
Stomata in field 3			
Average stomata in field			
Total			

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

Answer (a,b,c,d)	Marks

Problem 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:
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4.2. Write down measurements (4 p)

<i>Wavelength, nm</i>	<i>A, AU</i>	<i>Marks</i>

4.3. See Graph2 attached (4 p)

Filled out by evaluator

Marks for graph _____	Marks:
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4.4. See Graph1 and Graph2 attached (4 p)

Filled out by evaluator

Marks for intervals marked on graph _____	Marks:
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4.5. See Graph1 attached (3 p)

Filled out by evaluator

Marks for interval fractions marked on graph _____	Marks:
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4.6. See Graph1 attached (3 p)

Filled out by evaluator

Marks for radiation power per square metre calculated _____	Marks:
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4.7. Write down your calculated k and show your calculation (2 p)

	Your answer	Marks
Show calculation		
k		
Total marks		

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:
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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		
Transmittance		
Total marks		

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

4.11. Write down your calculated sum in the answer sheet (1 p)

Total absorbed radiation power	Marks

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 square metre of cucumber leaf	Marks

Problem 5 - Exploring hydroponics

5.1. Write down the measurements (1 p).

	Your answer	Marks
Initial length of tubes		

5.2. Write down the measurements and do the calculations for each tube length in the table (3 p)

	Length of tube, m	h, m	$\Delta p, Pa$	$\Delta V, ml$	$\Delta t, s$	Marks
Total marks						

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

	Length of tube, m	h, m	$\Delta p, Pa$	$\Delta V, ml$	$\Delta t, s$	Marks
long						
short						

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

	Calculations	Marks
Q for the longest tube		

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

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

5.6. Write trendline equation here (2 p)

		Marks
Trendline equation		

5.7. Write down your obtained n (2 p)

		Marks
n		

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

	Calculations	Marks
Length of the tube		

Problem 6 - Setting up the greenhouse.

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

Answer (a,b,c,d)	Marks

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

Answer (a,b,c,d)	Marks

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, 0)	Marks
Leaves would receive too little of light		
You would experience economic losses		
Air in the greenhouse would be too humid		
Total marks		

6.4. Write your calculations. (2 p - 1 p for correct assessment of cucumber leaf area, 1 p for calculating the planting area)

Calculations	Marks

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

Answer (a,b,c,d)	Marks

6.6. *Mark the letters of the correct answers (2 p)*

Answer (a,b,c,d)	Marks

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

Answer (a,b,c,d)	Marks