THE ANSWER IS

BLOWING IN THE WIND

ANSWER SHEET

Challenge 1

28th of April 2015

Country:

Team:

Names and signatures

_____

_____

_____

Task A

1. The ecology of *Astacus astacus subsp. virtuliensis*

1.1. Match the characteristics (left column) that correspond to the correct ecological concepts (biotope, habitat, ecological niche) through ticking the correct box!

(9 Marks)

Characteristics of biotope, habitat, ecological niche of *Astacus v.*	**Biotope**	**Habitat**	**Ecological niche**
Omnivore			
Actively collects food			
Rivers, streams, lakes			
Steep banks			
Strong structuring of the benthic area			
Minimum water temperature in summer 15 °C			
Nocturnal			
Oxygen concentration of the water			
Hiding places			

1.2. Astacus performance in response to water temperature in summertime (12 Marks)

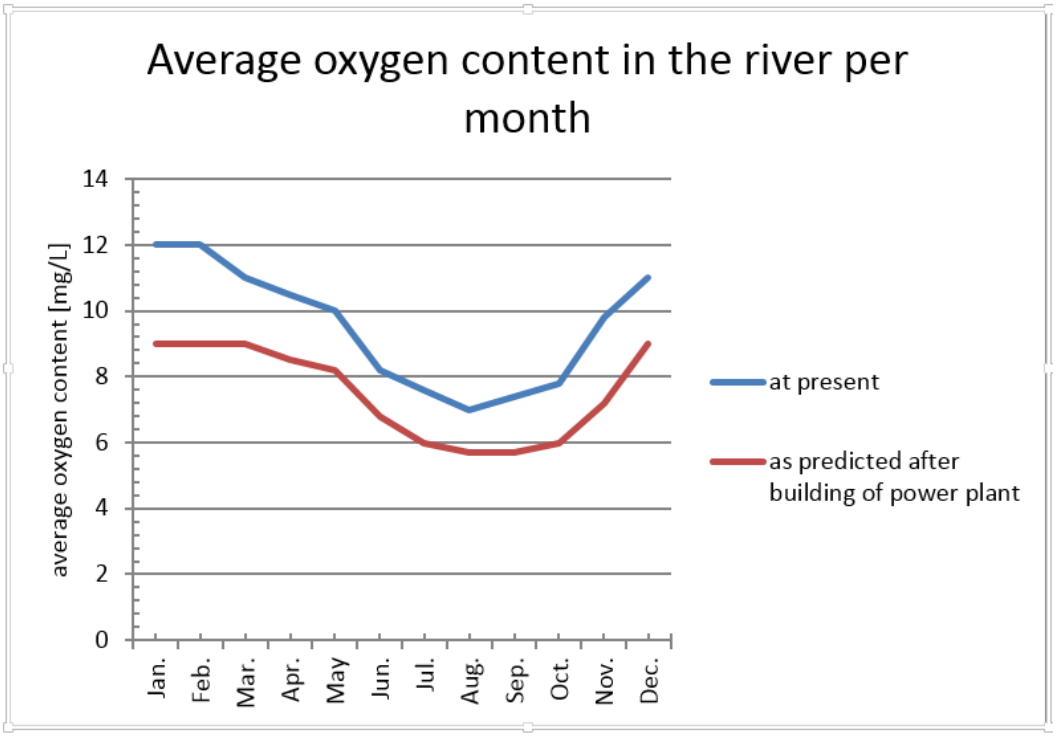
1.2.1 Draw a graph (bell-shaped curve) demonstrating the relationship between the stated water temperatures (minimum, optimum, maximum) versus species performance!

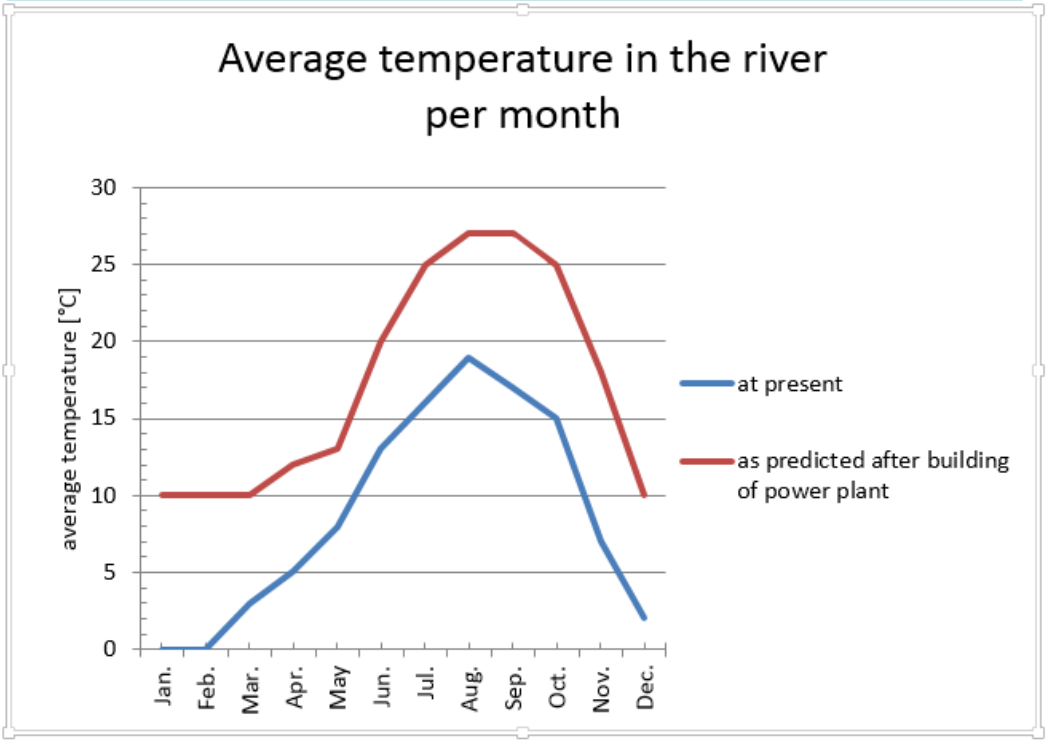
1.2.2 Label the graph of 1.2.1 with the characteristic temperature range and temperature points/temperature ranges (minimum, maximum, optimum, pessimum). Annotate the graph and add a legend.

Insert the graph (bell-shaped curve) demonstrating the relationship between the stated water temperatures (minimum, optimum, maximum) versus species performance!

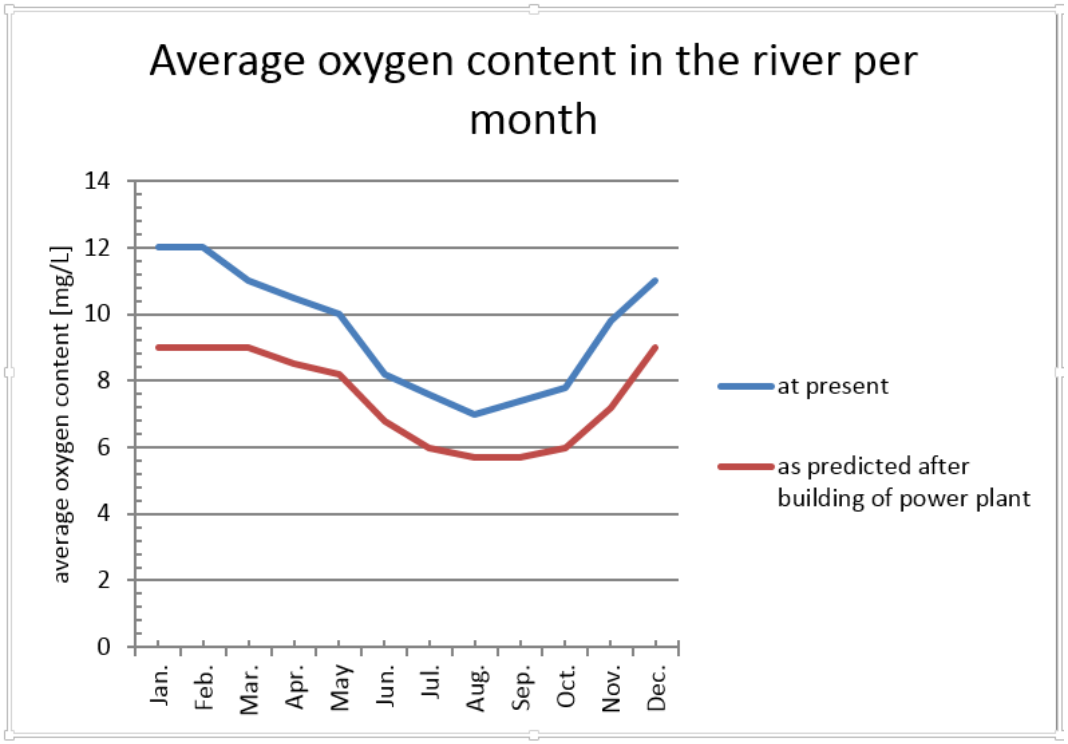
2. Possible effects of a pump station on *Astacus astacus subsp. virtuliensis*

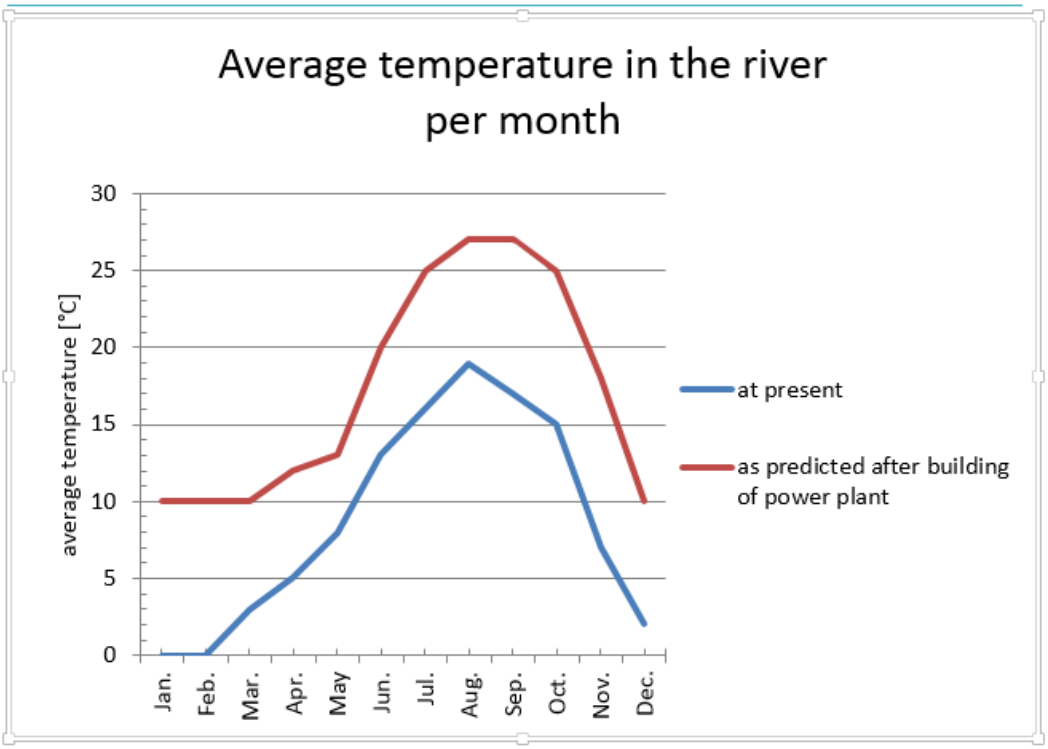
2.1 Identify areas in the graphs representing ecological factors that can lead to extinction of the crayfish population. Shade the area/s clearly. (3 Marks)





2.2. Clearly shade the optimal area/s for temperature and oxygen content in summer within the graphs. (5 Marks)





3. Functional morphology of crayfish

Reminder: Take care of the order in which the tasks are completed.

Before starting section 3.2 and 4 you have to solve 3.1 and hand over the **crayfish handout** 3.1 to the laboratory assistant.

3.1. On the provided crayfish handout, arrange the crayfish extremities from the glass container in the correct order. ⇨ *crayfish handout*

(20 Marks)

A picture has been taken of the finished ***crayfish handout*** by the laboratory assistant. (The country label must be clearly visible on the picture!)

Signature laboratory assistant:_____

Hand over the *crayfish handout* to the laboratory assistant! Now you will receive:

- **the table "Function"**
- **a diagram showing the morphology of crayfish**
- **a crayfish for identification.**

3.2. Match each extremity to its main function (multiple assignments are possible, but maximally three assignments per extremity are allowed).→ *Table "Function"*

Each box must show either a cross or a zero: "X" for correct, "0" for incorrect!! (10 Marks)

4. Crayfish identification

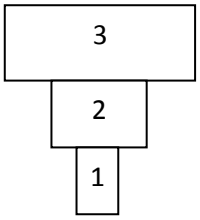
4.1. Tick the statements on the key in the grey column that lead to the identification of the presented crayfish! (9 Marks)

Key to native and alien crayfish species in Europe				
1 a		Undersides of chelipeds are red or orange	go to **2**	
1 b		Undersides of chelipeds are neither red nor orange	go to **4**	
2 a		one postorbital ridge	**Red swamp crayfish** **Louisiana crayfish**	*Procambarus clarkii*
2 b		two postorbital ridges	go to **3**	
3 a		Sharp spines behind the cervical groove	**Noble crayfish**	*Astacus astacus subsp. virtuliensis*
3 b		No sharp spines behind the cervical groove, carapax and surface of chelae smooth	**Signal crayfish**	*Pacifastacus leniusculus*
4 a		Spines behind the cervical groove	go to **5**	
4 b		No spines behind the cervical groove	**Stone crayfish**	*Austropotamobius torrentium*
5 a		one postorbital ridge	go to **6**	
5 b		two postorbital ridges	**Danube crayfish** **Galician crayfish**	*Astacus leptodactylus*
6 a		no transverse maroon bands across abdominal segments	**White clawed crayfish**	*Austropotamobius pallipes*
6 b		transverse maroon bands across abdominal segments	**Eastern Crayfish** **Delcore Crayfish**	*Orconectes limosus*

4.2. Write the correct Latin name of the crayfish you have identified!! (2 Marks)

5. Theoretical questions

5.1. Which of the statements are correct, which are incorrect? Tick your choice! (10 Marks)

Statement	correct	incorrect
The organs of equilibrium in crayfish are called statocysts		
The Nautilus larva is an early developmental stage of decapods.		
Crayfish eyes show the same basic bauplan as cephalopods.		
The scheme shows the age distribution of a crayfish population that most likely becomes extinct: 3: Reproduction completed 2: Capable of reproduction 1: Young 		
The competition between two populations of different species is stronger if the ecological niches of these species highly overlap.		

6. Evaluate the situation of constructing a pump station in Kleinvirtulien! (10)

Factor		Effect	
		Yes	No
Crayfish population	*Astacus astacus ssp. virtuliensis* identified		
Regardless of your identification result: For the individuals *Astacus astacus ssp. virtuliensis* that exist in the valley	Danger of extinction given		
Threat of the habitat through changes in the environment (Assessment)	Pump station		
	Electrolysis station	**No answer expected**	
Threat to the crayfish population through reduced O_2 water content	Pump station		
	Electrolysis station	**No answer expected**	
Threat to the crayfish population through increased water temperatures in summer	Pump station		
	Electrolysis station	**No answer expected**	

TASK B

1. Calculate the concentration of Cr(VI) in the stock solution in mg/L.

(6 Marks)

Calculation:

For the lab assistant: The result is correct ☐ wrong ☐

The correct result is: ……..

Signature of lab assistant: _____

2. Determination of the calibration curve and spectophotometric measurement

2.1. Calculate the volume of stock solution required to prepare 10 mL of the respective solutions. Record the values in table 1! (8 Marks)

Calculation (one example):

Table 1

	Cr(VI)-conc. (in µg/L)	Stock solution (in µL)
Calibration solution 1 (Blank)	0	0
Calibration solution 2	25,0	
Calibration solution 3	50,0	
Calibration solution 4	100	
Calibration solution 5	200	
Calibration solution 6	250	

2.3.1. Calculate the dilution factor for the eluates. (2 Marks)

Calculation:

For the lab assistant: The result 2.3.1 is correct ☐ wrong ☐

The correct result is: …….

Signature of lab assistant: _____

2.4. Spectrophotometer measurement (24 Marks)

Table 2

Test tube	**Solution**	**Absorption at 550 nm**
1	Calibration solution 1 (blank)	
2	Calibration solution 2	
3	Calibration solution 3	
4	Calibration solution 4	
5	Calibration solution 5	
6	Calibration solution 6	
7	Eluate 1	
8	Eluate 2	
9	Eluate 3	
10	Eluate 4	
11	Eluate 5	
12	Reference solution	

3. Plotting a graph (absorption versus concentration) (20 Marks)

Hand in your graph paper to the lab assistant!

For further calculations, you must use the values you will get from the lab assistant.

The graph paper has been handed in.

Slope: …… Intercept:…….

Signature of lab assistant: _____

4. Calculate the concentration of eluates 1-5 and the reference solution.

(Provide your answer in µg/L for the Cr(VI) concentrations in the eluates and the reference solution) (9 Marks)

Calculation:

Table 3		
Solution	**Cr(VI) concentration in µg/L without taking into account the diluting factor**	**Cr(VI) concentration in µg/L taking into account the diluting factor**
Eluate 1		
Eluate 2		
Eluate 3		
Eluate 4		
Eluate 5		
Reference solution		

5. Cr(VI) content of soil samples in mg/kg (10 Marks)

Calculation:

Table 4	
Soil samples	**Cr(VI) concentration in mg/kg**
Soil sample 1	
Soil sample 2	
Soil sample 3	
Soil sample 4	
Soil sample 5	

6. Cr(VI) pollution in the soil and the reservoir (8 Marks)

Calculations:

6.1 Average Cr(VI) content in the soil? _____

6.2 Amount of Cr(VI) in the landfill? _____

6.3 Cr(VI) concentration in the reservoir? _____

6.4 Should the reservoir be built? Circle your choice! **yes / no**

7. Concluding questions

Tick **yes** or **no!** (5 Marks)

		yes	no
7.1	Are there any quality-assuring measures in this task?		
7.2	In this task, would using cuvettes with a 2 cm pathlength instead of 1 cm lead to twice the Cr(VI) concentration?		
7.3	Does working in the non-linear range of the calibration curve lead to less exact results?		
7.4	In this task, would the absorption be higher if a wavelength of 600 nm was used?		
7.5	Does a transmission value of 1 correspond to an absorption value of -1?		

Task C

1. Measurements of a wind machine

1.1. Measurement of air speed

1.1.1. Complete Table 1.1.1 with the corresponding values (5 Marks)

Table 1.1.1 Table of air speed (m/s)

Wind machine level	Average speed (AV)	Maximum speed (MX)
1		
2		
3		
4		
5		

1.1.2. Draw the Diagram "Wind machine level – air speed" (10 Marks)

Paste your diagram here!

1.2. Measurements of the off-load voltages with various rotor blades

Insert the voltage values recorded into Table 1.2! (5 Marks)

Table 1.2 : Table of voltages (V)

	rotor blade - 16 cm	**rotor blade - 18 cm**	**rotor blade - 20 cm**	**two rotor blades - 16 cm**	**rotor blade (inverted) - 16 cm**
Level	off-load voltage (U_0)	off-load voltage (U_0)	off-load voltage (U_0)	off-load voltage (U_0)	off-load voltage (U_0)
1					
2					
3					
4					
5					

1.3. Output power of various propellers (25 Marks)

Tables of output power

- **Insert your measured values of voltages and currents in the tables 1.3.1 – 1.3.5.**
- **Calculate the respective power and insert it in the tables 1.3.1 – 1.3.5**
- **Insert your values in the diagram.**

Joker used : ☐

Table 1.3.1 Rotor blade 16 cm

resistor	current	voltage	power (calculated)
1 Ω			
3 Ω			
5 Ω			
10 Ω			
50 Ω			
100 Ω			
200 Ω			

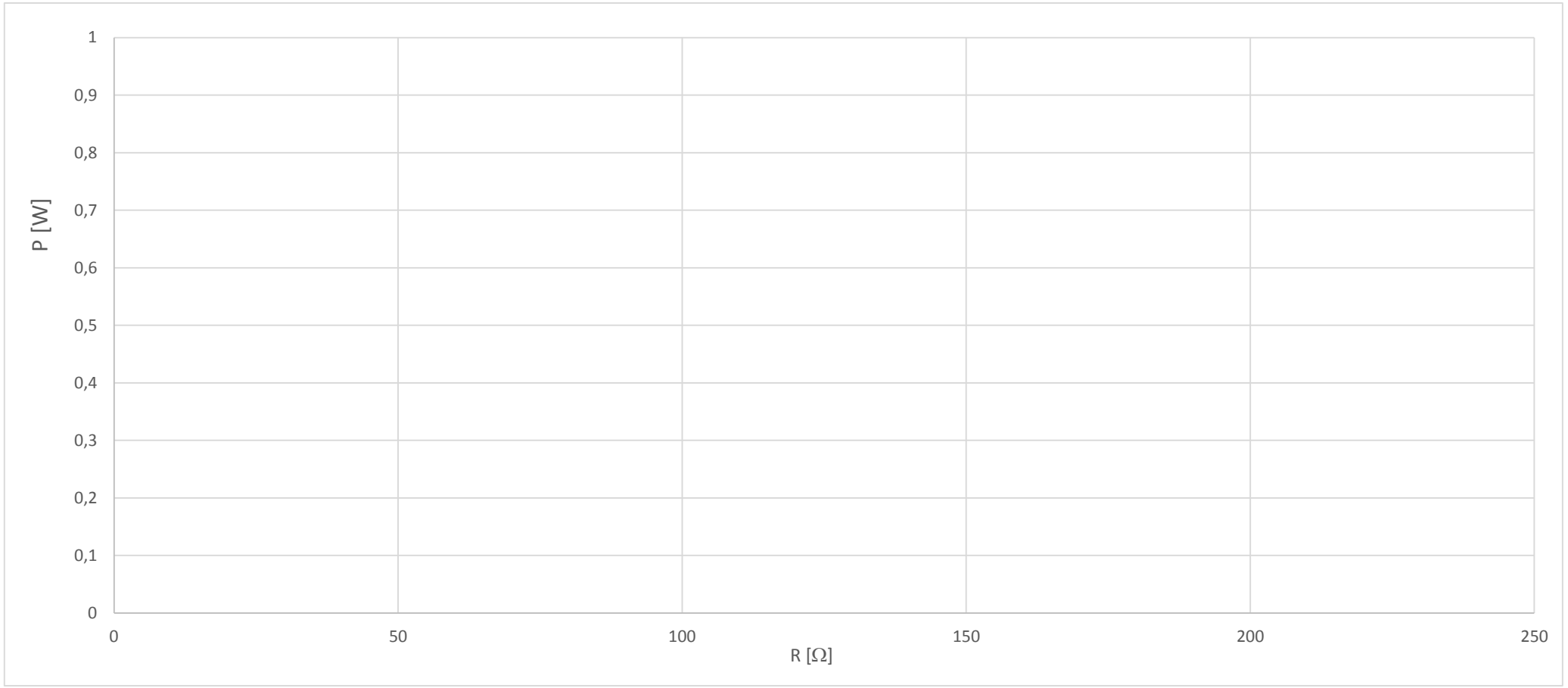
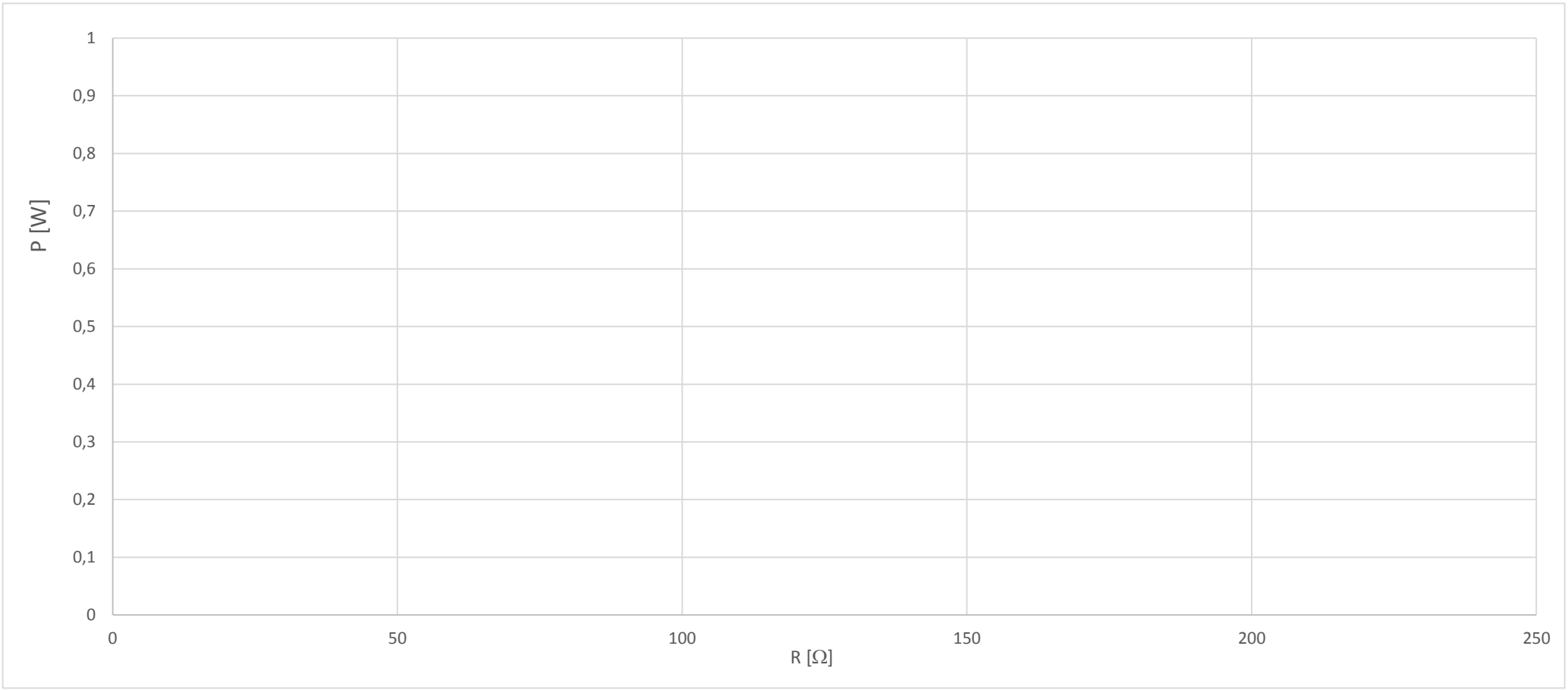
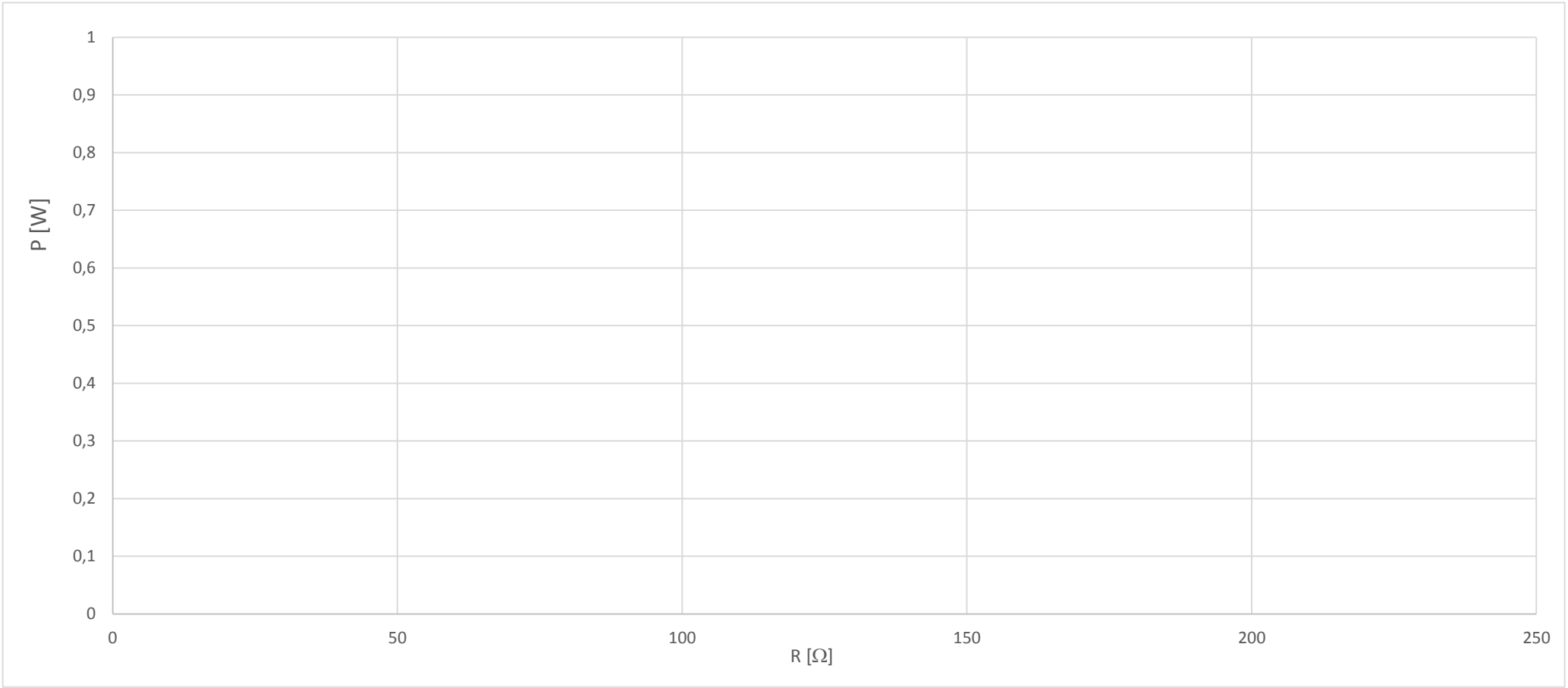


Table 1.3.2 Rotor blade 18 cm	resistor	current	voltage	power (calculated)
	1 Ω			
	3 Ω			
	5 Ω			
	10 Ω			
	50 Ω			
	100 Ω			
	200 Ω			



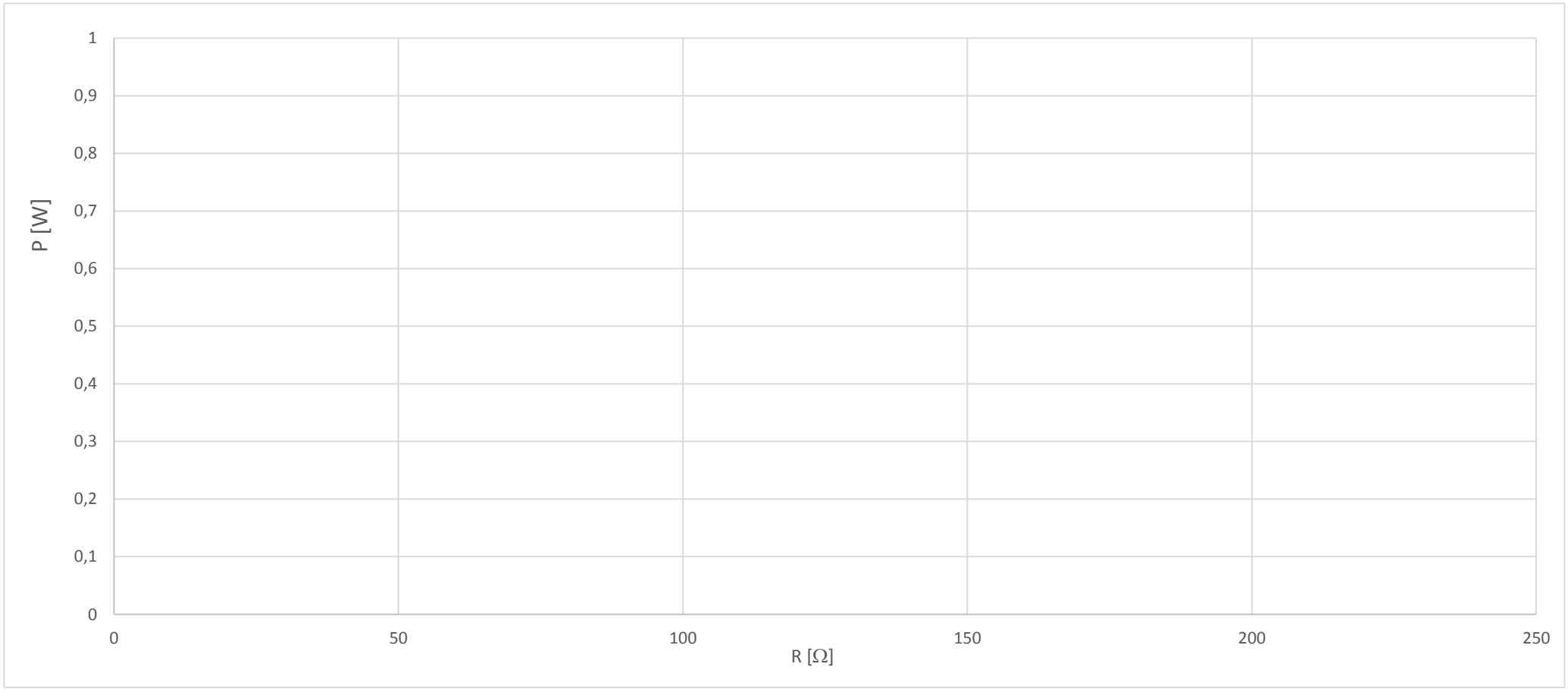
COUNTRY: 19-.04.2015 TEAM:

Table 1.3.3 Rotor blade 20 cm	resistor	current	voltage	power (calculated)
	1 Ω			
	3 Ω			
	5 Ω			
	10 Ω			
	50 Ω			
	100 Ω			
	200 Ω			



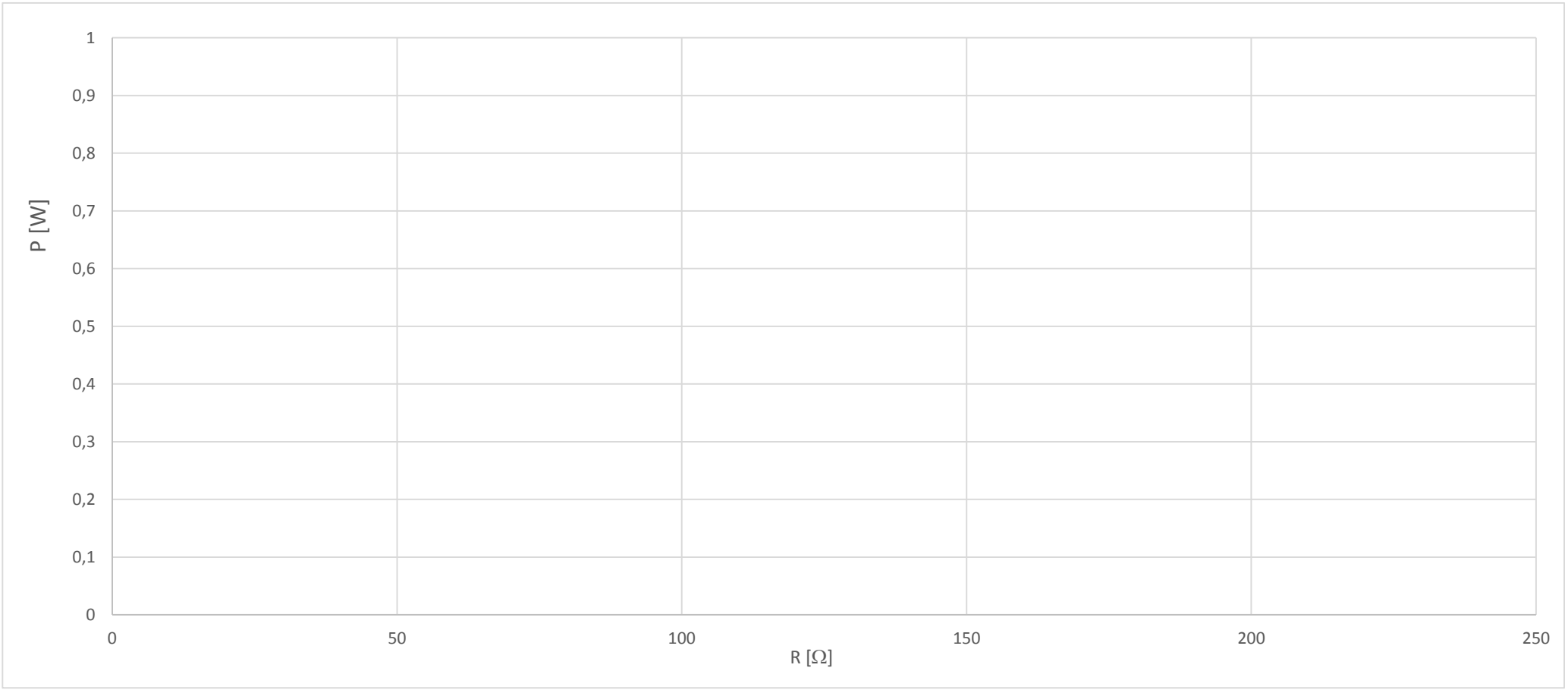
COUNTRY: 19-.04.2015 TEAM:

Table 1.3.4 Two rotor blades	resistor	current	voltage	power (calculated)
	1 Ω			
	3 Ω			
	5 Ω			
	10 Ω			
	50 Ω			
	100 Ω			
	200 Ω			



COUNTRY: 19-.04.2015 TEAM:

Table 1.3.5 Rotor blade (inverted) 16 cm	resistor		current	voltage	power (calculated)
	1	Ω			
	3	Ω			
	5	Ω			
	10	Ω			
	50	Ω			
	100	Ω			
	200	Ω			



COUNTRY: 19-.04.2015 TEAM:

2. Measurements on a model of a PowerToGas facility

2.1 Electrolysis (3 Marks)

For the lab assistant:

Short circuit ☐ correct ☐ wrong

Current ☐ correct ☐ wrong

Voltage ☐ correct ☐ wrong

Signature of lab assistant: _____

2.1.1. Measurement of the power at the electrolyser with different air speeds

Insert the measured and your calculated values in table 2.1.1! (5 Marks)

Table 2.1.1			
wind machine	**voltage (V) (electrolyser)**	**current (A)**	**power (W)**
level 1			
level 2			
level 3			
level 4			
level 5			

2.1.2. How much electrical energy is needed to produce 10 ml hydrogen?

Insert the values and your result! (5 Marks)

Voltage (V):	
Current (A):	
Time (s):	
Electrical energy (J):	

Joker used : ☐

2.1.3. Efficiency of the electrolysis procedure

Calculate the efficiency of the apparatus using the result from 2.1.2 (3 Marks)

2.2. Fuel cell

2.2.1. Released electrical energy of a fuel cell **(5 Marks)**

Calculate the average electrical energy with the measured values of voltage, current, and time. Insert these values!

Voltage (V):	
Current (A):	
Time (s):	
Electrical energy (J):	

2.2.2. Efficiency of the fuel cell (3 Marks)

Determine the efficiency of the fuel cell by comparing the caloric energy of 10 ml hydrogen and the released electrical energy!

3. Comparison of realistic facilities

3.1. Power of a planned wind power plant

3.1.1. Calculate the power of this wind power plant assuming a wind speed of 40 km/h. Give the result in units of Megawatt (MW). (3 Marks)

3.1.2. Calculate the energy produced in one day (MWh) under these conditions. (2 Marks)

3.2. Power of a planned pump storage facility

3.2.1. Power of the planned storage facility

Calculate the potential energy of the water pumped up in 1 s. (3 Marks)

Joker used :

3.2.2. Energy in the system

Calculate: How much water can be transported up each day, assuming maximum power of the wind power plant? (3 Marks)

3.2.3. Total efficiency

Calculate the total efficiency of the pump storage facility. (2 Marks)

3.3. Dimensions and efficiency of a planned PowertoGas facility

3.3.1. Electrolysis (3 Marks)

Calculate the amount of hydrogen gas that can be produced each hour, if the wind power plant runs at full power.

3.3.2. Total efficiency of the PowertoGas facility (2 Marks)

Calculate the total efficiency of the electrolysis-fuel cell facility.

3.4. Comparison of both facilities (5 Marks)

Table 3.4

	Yes	No
Can the power storage facility supply the power of the wind park?		
The capacity of the upper reservoir of the pump storage facility is 80 million m³ at most. Can it store the maximum energy of the wind park produced in one month?		
The gas storage of the electrolysis facility has a capacity of 2000 m³ hydrogen per hour, at most. Can it supply the maximum power of the wind park?		
	Pump storage	Power To Gas
Which facility has the higher total efficiency?		
Which of these two facilities do you recommend for construction?		

Task D

Recommendation of the science team for the power station construction in Klein Virtulien

1. **Summarize your results as a team in the table <u>"Findings"</u> to help you come to a common statement in table <u>"Recommendation"</u>!**

Table Findings	**Yes**	**No**
Crayfish worth protecting are found in the valley and danger of extinction is given.		
The capacity of the pump storage facility is better suited than that of the "Power-to-Gas" facility.		
Chromium (VI) exceeds legal limits for drinking wate.		

2. Indicate your team <u>recommendation</u> in the table "<u>Recommendation</u>"!

(6 Marks)

Table Recommendation	**Yes**	**No**
A conventional pump storage station should be built.		
A modern electrolysis station (Power-to-Gas,P2G) should be built.		

Task E

Facts about.....

Evaluate the following statements! **(24 Marks)**

Table "Facts about…."			
Facts	**Statements**	**correct**	**incorrect**
Facts about chromium	Chromium is an important alloy component in stainless steel.		
	Chromium is a main compound of chromosomes.		
	Chromium(III) compounds are known for their yellow colour.		
Facts about water	Freshwater osteichthyes actively take up electrolytes with their branchiae from the surrounding water and excrete highly concentrated urine.		
	The pH of pure water increases with rising temperature.		
	A fully filled water reservoir of 45m depth has a concrete dam at its end. The force of water exerted from the inside onto $1m^2$ of the dam is about 450.000 N.		
Facts about energy	ATP is the cell's energy carrier. In all organisms the ATP synthesis takes place in the mitochondria.		
	Negative reaction enthalpy implies an endothermic reaction.		
	The solar constant is about 1,4 N/m^2.		
Facts about biomolecules	The blood of some crayfish contains copper ions.		
	Peptides are always larger than proteins.		
	The mass of one biomolecule is always smaller than that of one lead atom.		