



11th EUROPEAN UNION SCIENCE OLYMPIAD

Test 1

Marking scheme

Luxembourg, March 19th,
2013

TASK 1: DETERMINATION OF SiO₂ IN WATER

TASK 1.1: Preparing the calibration solutions (8 marks):

1 mark for each correct answer.

Indicate the SiO₂ concentration of the silicium stock solution: ...**2139**.....mg/L

Indicate the volume of stock solution used for the 50fold dilution in the 10 mL flask:.....
0.2.....mL

SiO₂ concentrations of the calibration solutions (**indicate 3 significant numbers**):

	SiO ₂ solution B (mL)	Water (mL)	SiO ₂ Concentration [mg/L]
1	0	2	0.00
2	0.1	1.9	2.14
3	0.2	1.8	5.35
4	0.4	1.6	10.7
5	0.8	1.2	21.4
6	1.6	0.4	32.1

TASK 1.2: Establishing the calibration curve (16 marks):

1.2.1 Complete the following table:

Unknown 3	Concentration [mg/L]	Absorbance reading at 800 nm
1	0.00	
2	2.14	
3	5.35	
4	10.7	
5	21.4	
6	32.1	
Unknown 1		
Unknown 2		

On a sheet of millimeter graph paper, draw the absorbance values of each calibration solution vs the concentration.

- *Correct size (3/4 of page) and correct scales: 1 mark*
- *Correctly plotted values: 2 marks*
- *Units on x-Axis: 1 mark*
- *Correctly drawn a line of best fit (between points): 2 marks*

Calculate the slope of the obtained calibration curve: **2 marks**

1.2.2 Add the absorbance readings of the unknown samples on the graph.

Unknowns plotted correctly (absorbance reading marked at y-Axis, deducted concentration at x-Axis)

2 marks

1.2.3 Determine the SiO₂ concentration of the unknown samples graphically and by calculation **6 marks**

Concentration determined by calculation:

0.5 marks per correctly calculated value, 0.5 marks for each result within the following ranges:

Unknown 1 (Evian: 12 – 18 mg/L)

Unknown 2 (Tap water: 5 – 10 mg/L)

Unknown 3 (prepared concentration in distilled water: 21.4 mg/L ± 10%) 19.3 – 23.5 mg/L)

Concentration determined out of the graph:

0.5 marks for getting a correct result from the graph, 0.5 marks for each result within the following ranges:

Unknown 1 (Evian: 12 – 18 mg/L)

Unknown 2 (Tap water: 5 – 10 mg/L)

Unknown 3 (prepared concentration in distilled water: 21.4 mg/L ± 10%) 19.3 – 23.5 mg/L)

TASK 3: Error estimation (6 marks)

1.3.1 Indicate which of the following sentences is correct.

(1 mark per each correct statement, -1.5 mark for each error)

	Correct	Wrong
The proposed experimental has been setup in a way to avoid systematic errors.	X	
In order to reduce the effect of random errors, one would need to add additional points to the calibration curve.		X
A reduction of the random errors could be achieved by repeating the overall manipulation for the unknown samples and calculating the average of the obtained results.	X	
If samples fall within the non linear range of the calibration, curve, a dilution of the samples would yield a more precise result for the SiO ₂ concentration than the use of a non-linear fitted curve.	X	
The whole experiment could be carried out in glass cuvettes without an effect on the overall precision of the results.		X
A one point calibration forced through the origin of the plot would yield the same precision as obtained with 6-point calibration proposed in the experimental setup.		X

TASK 2: DIATOMS, LIFE IN A SILICA BOX

2.1 Identification and dimensions of diatoms

(4 marks)

Identify the species using the photographic identification guide and measure the mean length of these four diatom species :

Diatom species	Mean length in μm	marks
<i>Navicula cryptotenella</i> (NCTE)	15-20	1
<i>Amphora pediculus</i> (APED)	10-15	1
<i>Mayamaea perinitis</i> (MPMI)	7-10	1
<i>Nitzschia dissipata</i> (NDIS)	15-20	1

2.2 Determination of the degree of pollution of the rivers 'Syre' and 'Gander'

Identify the species present, fill in the name with the corresponding code name and the total number (A = abundance) of each species. Calculate A in %, ($S \cdot V \cdot A$) and ($S \cdot A$) of each species and the Sum (Σ). (S) & (V) values for each species may be found in table I.

River 'Syre'								(10 marks)
Diatom species name	CODE name	(A) in %	marks	(S)	(V)	($S \cdot V \cdot A$)	($V \cdot A$)	
	APED	23-30	2					
	NCTE	18-31	2					
	NDIS	15-22	2					
	MPMI	8-14	1					
	ADSA	2-5	0.5					
	GOLI	2-5	0.5					
	RABB	2-5	0.5					
	NTPT	2-5	0.5					
	CLCT	2-5	0.5					
	NGRE	<2	0.5					
	NSOC	<2						
	NLAN	<2						
	NSTS	<2						
N=200	Sum (Σ)			/				

Pollution of the river 'Syre' :

(2 marks)

Correct calculations		1
IPS (1 - 20)	13-15	1
Biological quality	R	

River 'Gander' (10 marks)							
Diatom species name	CODE name	(A) in %	marks	(S)	(V)	(S*V*A)	(V*A)
	MPMI	27-43	2				
	ESBM	24-33	2				
	ADSA	16-24	2				
	NGRE	2-5	0.5				
	EOMI	2-5	0.5				
	NCTE	2-5	0.5				
	NSTS	2-5	0.5				
	GPAR	<2	0.5				
	APED	<2					
	NLAN	<2	0.5				
	NDIS	<2					
N= 200	Sum (Σ)			/			

Pollution of the river 'Gander' :

(2 marks)

Correct calculations		1
IPS (1 - 20)	7-9	1
Biological Quality	D	

2.3 Diatoms & technology (2 marks)

Alfred Bernhard Nobel (1833- 1896) was a famous swedish chemist, engineer and inventor.

He used his fortune to posthumously institute the well known Nobel Prizes.

He used diatomaceous earth (fossilized remains of diatoms), a siliceous sedimentary rock for his most famous invention. Which of the following inventions made him famous and rich?

Cracking of petrol	
Photovoltaik cells	
Dynamite	X
Window glass	
Quartz oscillators in watches	

TASK 3: SiO₂ IN SOLAR CELL TECHNOLOGY

Question 3A (5 marks)

Which of the following factors will reduce the solar efficiency of a solar module?

Items	Yes	No
Reducing N		x
Contact grid reducing the photo-absorbing surface	x	
Part of the incoming light being reflected	x	
Choosing a solar cell material with lower quantum yield	x	
Increasing the energy of the photons (assume a invariant quantum yield)	x	
Dirty glass layer	x	
Thicker layer of n-type semi-conductor	x	
Thicker layer of p-type semi-conductor		x
Choosing a very high load resistance	x	
Choosing a very low load resistance	x	

For each wrong answer 1 mark is deduced

Task 3.1: Open-circuit voltage U_{oc} and short-circuit current intensity I_{sc} (2 marks)

Cell number	59
Open-circuit voltage U_{oc}	0.523 V
Short-circuit current intensity I_{sc}	100.6 mA

1 mark for each correct value

Task 3.2: Current - voltage and power - voltage characteristics (14 marks)

Measurements from a practical test of the solar cell number 59; variations are possible for other cells

I (mA)	U (V)	P (mW)
0,0	0,520	0,0
5,0	0,517	2,6
10,0	0,514	5,1
15,1	0,510	7,7
20,2	0,507	10,2
25,1	0,514	12,9
29,9	0,501	15,0
35,0	0,496	17,4
40,1	0,493	19,8
45,4	0,488	22,2
50,3	0,483	24,3
55,0	0,479	26,3
60,0	0,473	28,4
65,3	0,466	30,4
70,3	0,459	32,3
75,4	0,450	33,9
80,2	0,440	35,3
85,1	0,426	36,3
90,1	0,407	36,7
95,0	0,378	35,9
99,6	0,318	31,7
101,1	0,272	27,5

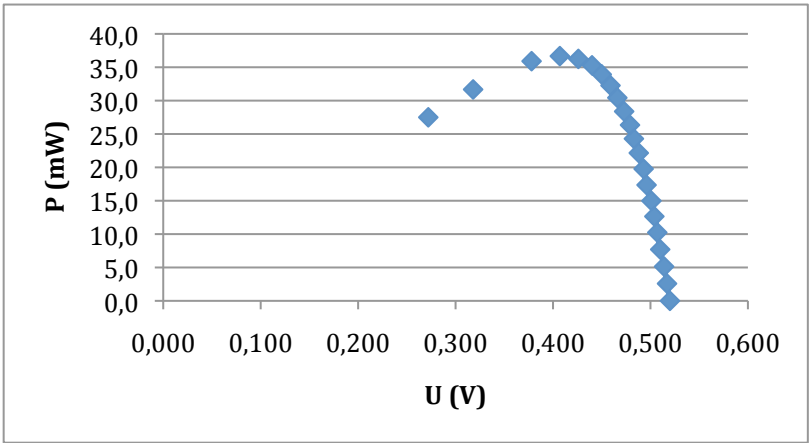
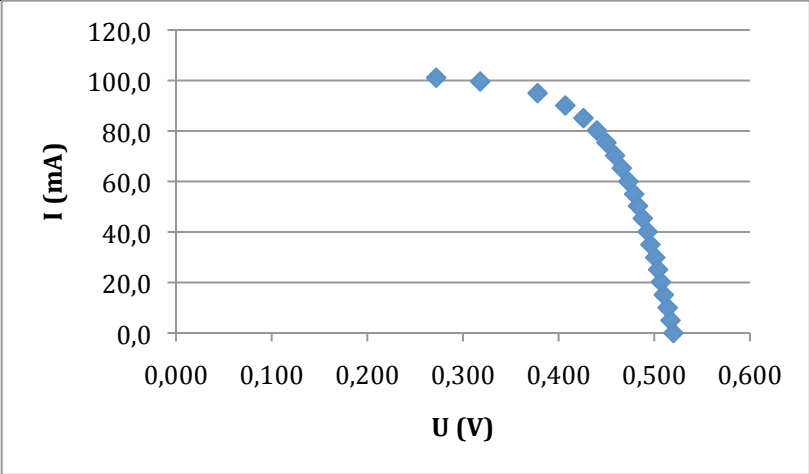


Table (5 marks)

Correct measurement range: 1 mark

Performed 15 measurements or more: 2 marks (less: 1 mark)

Correct values (I-U characteristic) 1 mark

Correct values (P-U characteristic): 1 mark

Graph (9 marks):

Correct size (3/4 of page) and correct scales: 1 mark

Correctly plotted values: 2 marks

Different symbols used for the different characteristics: 0.5 mark

Correctly drawn best-fit lines 2 marks

Units on the axis: 1.5 mark (0.5 mark for each correct)

The power rectangle correctly drawn: 1 mark

Maximum power point	I_m (mA)	U_m (V)	P_m (mW)
	90.1	0.407	36.7

1 mark for the correct answer

Question 3B (2 marks)

The efficiency of your solar cells (see formula 1) at the maximum power point is roughly equal to 8 %. What is the incident light power per surface unit?

Incident light power per surface unit (W/m^2)	183
---	-----

Surface of the cell = 25 cm^2

2 marks for the correct answer

Task 3.3: Combination of solar cells (6 marks)

Series combination	Cell number	I (mA)	U (V)
First cell	58	40	0.463
Second cell	59	40	0.396
Cells in series		40	0.863

Parallel combination	Cell number	I (mA)	U (V)
First cell	58	49.9	0.40
Second cell	59	39.6	0.40
Cells in parallel		89.8	0.40

1 mark for each correct measurement (uncertainty less than 5%)

Question 3C (4 marks)

Number of cells in series	30
Number of series circuits in parallel	10

Correct number of cells in series: 2 marks

Correct number of circuits in parallel: 2 marks