IJSO 2019 DOHA, QATAR

16th International Junior Science Olympiad

Practical Exam

MARK SCHEME

DECEMBER 9th, 2019

Country			
	Student 1	Student 2	Student 3
Name			
Code			
Signature			

Task 1:

Identification of Contaminated Water Samples

Part-A — Record the obtained colour in the Table below (Table 1) by putting a check mark (√) in the corresponding column.

Lugol's Test Points: (0.75 pt.)

Table 1. Data obtained from Lugol's test.

Observed colour	Sample (BIOL-A)	Sample (BIOL-B)	Sample (BIOL-C)	Sample (BIOL-D)
Yellowish brown		√	√	√
Bluish black	√			

0.75 pt . for identifying the sample **(BIOL-A)** as bluish black, Selecting more than one sample as bluish black = zero.

Part-B — Record the obtained colour in the Table below (Table 2) by putting a check mark (√) in the corresponding column.

Biuret Test Points: (0.75 pt.)

Table 2. Data obtained from Biuret test.

Observed colour	Sample (BIOL-A)	Sample (BIOL-B)	Sample (BIOL-C)	Sample (BIOL-D)
Violet			√	
Blue	√	√		√

0.75 pt . for identifying the sample **(BIOL-C)** as violet, Selecting more than one sample as violet = zero.

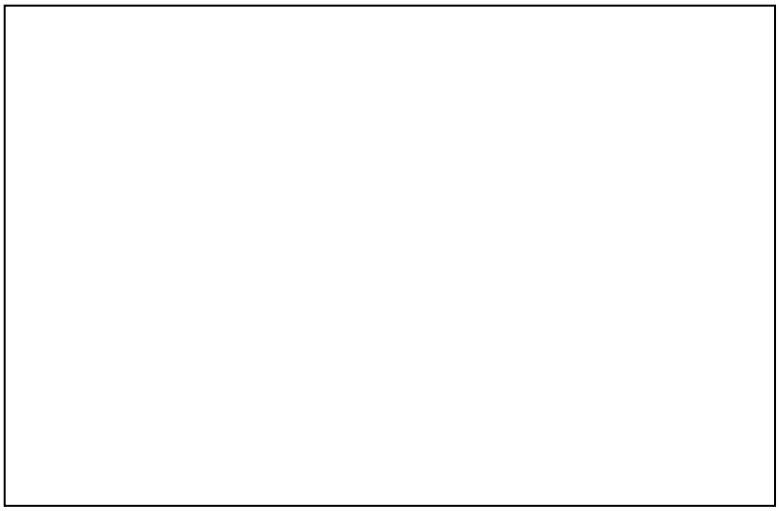
Part-C

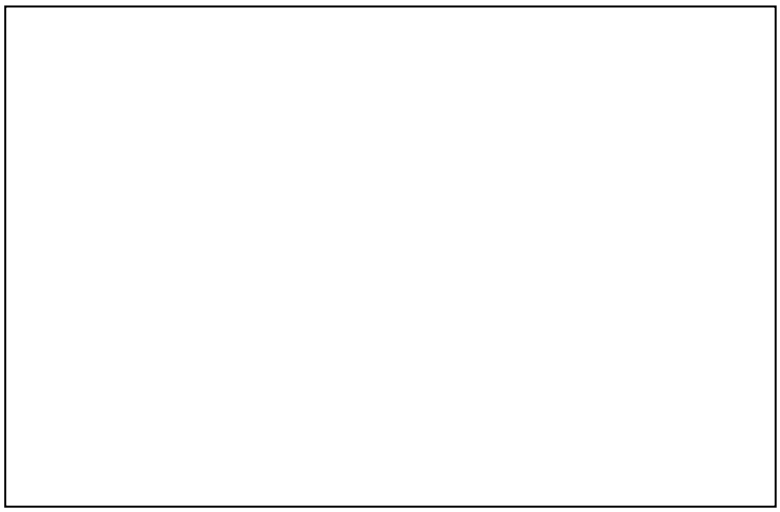
1. **Observe the slides under the microscope; draw one cell per sample that you see in each slide, title each drawing with the appropriate sample name.**

Provide a fully labelled biological drawing, including the magnification (for both of the slides) as well as to include the following key in either of the slides.

	W	**Cell wall**
	X	**Nucleus**
	Y	**Central Vacuole**
	Z	**Plasma membrane**

Points:
(8 pts.)





Total mark: 8 pts distributed as follows for

0.5 pt for putting the right sample name **for each drawing**; 0.5 pt for including the magnification on the sketch (total 2 pt)
0.50 pt for drawing in the appropriate area (at least 60% of the allocated space) **for each drawing**; (total 1 pt)
1 pt for drawing the complete outline of the cells for only one drawing;
1 pt for drawing the complete outline of the nucleus for only one drawing;
0.50 pt for No shading, dotting is acceptable **for each drawing**; (total 1 pt)
0.50 pt for drawing the appropriate cell (shrink/ not shrink) **for each drawing**; (total 1 pt)
1 pt for the labelling (wxyz) – 0.25 pt for each label in either of the sketches.

Points: Total 2.0 pts

2- Identify the water samples, by putting a check mark (√) in the corresponding column in front of the appropriate sample name.

	BIOL-A	BIOL-B	BIOL-C	BIOL-D
Desalinated water		√		
Seawater				√
Water contaminated with albumin			√	
Water contaminated with starch	√			

0.50 pt each (total 2.0 pts)

Points: 0.50 pt

3- Onion cells in desalinated water may be described as ..... (Please circle only one correct option)

I. Turgid **0.50 pt**

II. Flaccid

III. Plasmolyzed

IV. None of the above is correct

Points: 0.50 pt

4- Blood cells do not have the same structure as plant cells. What do you think could happen to a blood cell in a desalinated water sample after 30 minutes? (Please circle only one correct option)

I. Becomes 4lasmolyzed

II. Shrinks

III. Remains the same

IV. Undergoes hemolysis **0.50 pt**

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Total points for TASK ONE	
Signature	**Scorer:**
	Reviewer:
	Table leader:

Task 2:

Further Validation of Water Samples' Salinity Using Physics Approaches

First Method (Optics)

Record your measurements in Table 3

Points: 3.25 pts

Table 3. Data and calculations.

Measured distances (cm)	Trial 1	Trial 2	Trial 3	Correct answer	Mean ± uncertainty
For empty concave mirror (PR) (1.0 pt)				40 cm	0.25 pt for reporting the error. Which is 0.05 even only one time with any case.
For PHYS-A- filled mirror ($SR^{\backslash}$) (1.0 pt)				30 cm	
For PHYS-B- filled mirror ($SR^{\backslash}$) (1.0 pt)				28 cm	

All measured distances accepted with range of ± 0.5 cm (1 pt.)
All measured distances accepted with range of ± 1 cm (0.5 pt.)

Points: 0.50 pt

A. Find the focal length (f) of the concave mirror you used in this experiment.

$f \pm \Delta f =$ 20 ± 0.025 cm

0.50 pt (0.25 pt for the value, 0.125 pt for the unit and 0.125 pt for the uncertainty).

Points: 0.50 pt

B. Determine the refractive index of sample PHYS-A with respect to the air in the form (n_A), where n_A symbolizes the refractive index of sample PHYS-A. Show your calculations

N.B.:0.25 for calculation and 0.25 for the result

$$n_A = \frac{PR \text{ or } SR}{SR^{\backslash}} = \frac{40}{30} = 1.333$$

Points: 0.50 pt	C. Determine the refractive index of sample PHYS-B with respect to the air in the form (n_B), where n_B symbolizes the refractive index of the sample PHYS-B. Show your calculations. N.B.:0.25 for calculation and 0.25 for the result $n_B = \frac{PR \text{ or } SR}{SR'} = \frac{40}{28} = 1.428$
	D. Based on your findings from the above method (Optics), identify the identity of samples PHYS-A and PHYS-B. Circle the right answer in each case. PHYS-A: Seawater/ **desalinated water** PHYS-B: **Seawater**/ desalinated water

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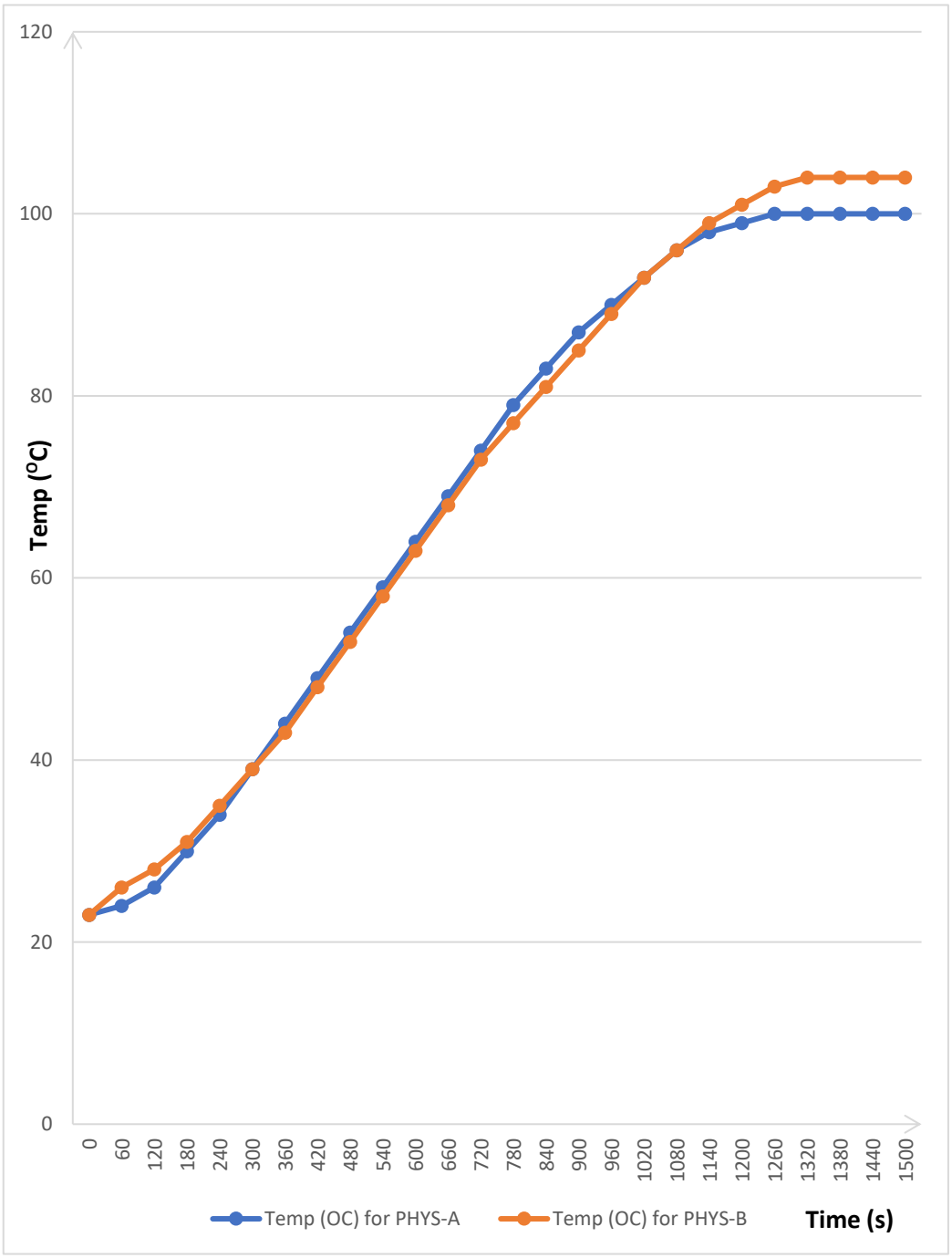
Total points for optics.	
Signature	**Scorer:**
	Reviewer:
	Table leader:

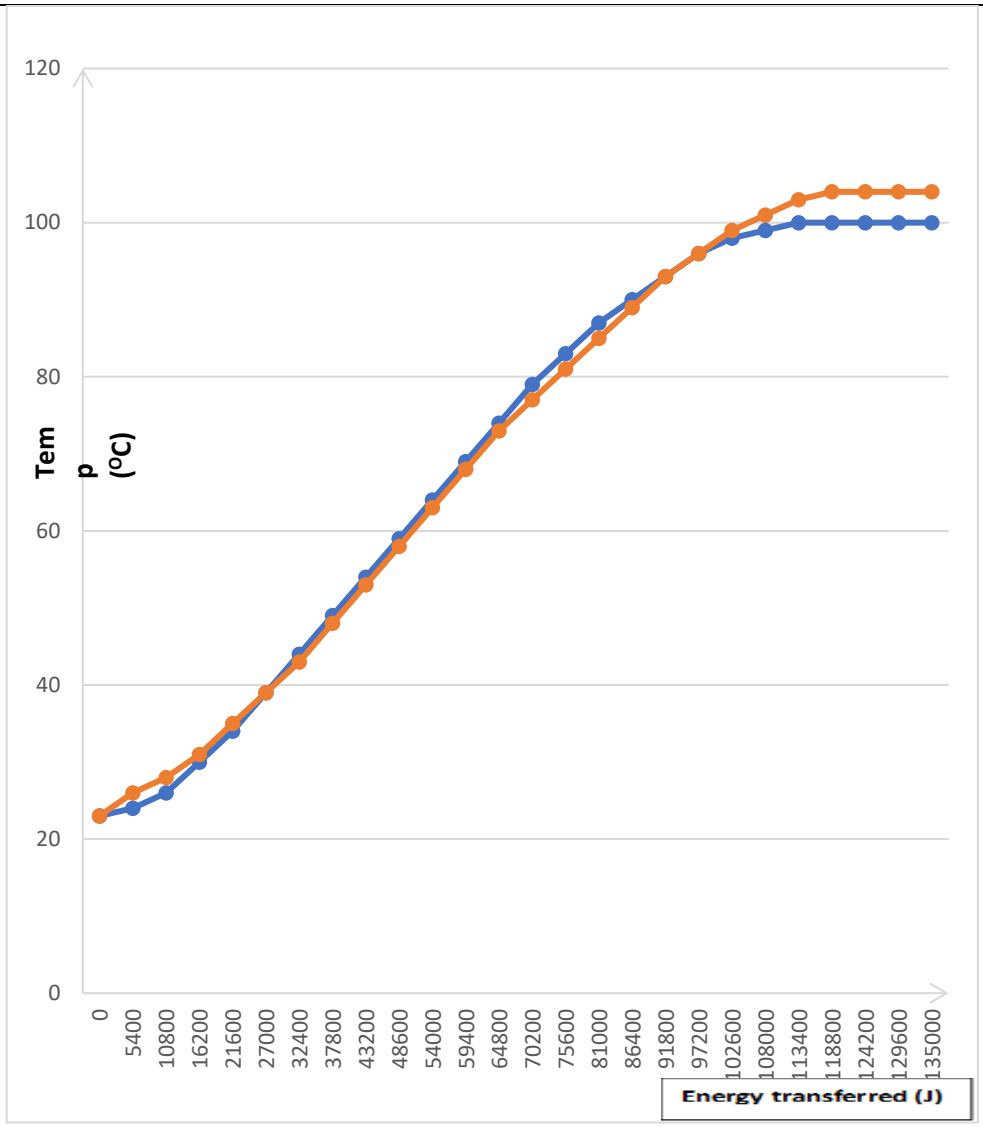
Record your measurements in Table 4

Table 4. Data collection sheet.

Time (s)	Temp (^{O}C) for PHYS-A	Temp (^{O}C) for PHYS-B	The energy transferred (Q)
0	23	23	0
60	24	26	5400
120	26	28	10800
180	30	31	16200
240	34	35	21600
300	39	39	27000
360	44	43	32400
420	49	48	37800
480	54	53	43200
540	59	58	48600
600	64	63	54000
660	69	68	59400
720	74	73	64800
780	79	77	70200
840	83	81	75600
900	87	85	81000
960	90	89	86400
1020	93	93	91800
1080	96	96	97200
1140	98	99	102600
1200	99	101	108000
1260	100	103	113400
1320	100	104	118800
1380	100	104	124200
1440	100	104	129600
1500	100	104	135000

(Second Method (Thermodynamics):	A. Plot (on the same graph) the measured temperature (T) against time (t) for both samples. - Correct labelling on each axis (0.125 pt.) total 0.25 pt. - Correct units on each axis (0.125 pt.) total 0.25 pt. - Scale (0.25 pt. for each)i.e. Total 0.5 pt. - More than 60% of the graph paper 0.25 pt. - Accurate representation of the data on the graph 0.25 pt. each i.e. Total 0.5 pt.
Points: 1.75 pts	

Points: **1.0 Pt**	B. From the graphs, deduce the gradients and intercepts of the initial straight-line portion on the T-axis. $Slope_A$ = $Slope_B$ = average value 0.07 $Intercept_A$ = $Intercept_B$ = average value 23 ^{O}C **Note:** *A denotes sample* PHYS-A and *B denotes* PHYS-*B.* 0.25 pt each - Total 1 pt. The value of the slope and intercept should be match the graph.
Points: **0.50 pt**	C. Write an equation that describes how temperature varies with time before the boiling point is reached. T= 0.07 t + 23 0.50 pt Temp. = $Slope_A$ x time + $Intercept_A$ Temp. = $Slope_B$ x time + $Intercept_B$ (0.25 pt. one equation only should be given).
Points: **1 pt**	D. From your graphs deduce the boiling point, $T_{(boil)}$ of sample PHYS-A and sample PHYS-B. $T_{(boil)}$ of sample PHYS-A: guiding range 98-100 $T_{(boil)}$ of sample PHYS-B: guiding range 102 -104 Difference in boiling Temp 2-6 degrees is acceptable giving that Salt water has higher boiling Temp.
Points: **1.75 pts**	E. Plot on another graph paper the measured temperature (T) against energy transferred (Q) for both samples. Use the graph paper provided and insert in the yellow answer sheet. - Correct labelling on each axis (0.125 pt.) total 0.25 pt. - Correct units on each axis (0.125 pt.) total 0.25 pt. - Scale (0.25 pt. for each)i.e. Total 0.5 pt. - More than 60% of the graph paper 0.25 pt. - Accurate representation of the data on the graph 0.25 pt. each i.e. Total 0.5 pt.



Points: 0.50 pt	F. What does the gradient of the initial straight-line portion of each plot (drawn in the previous question) relate to? Circle the correct answer I. mc II. $\frac{1}{mc}$ III. c IV. $\frac{1}{c}$
Points: 0.75 pt	G. Using your measured data, deduce the specific heat capacity, C, for samples PHYS-A and PHYS-B. Give your answer with the appropriate units. - the specific heat capacity, c, for sample PHYS-A. guiding range 4200 ± 100 j/kg.°C - the specific heat capacity, c, for sample PHYS-B. guiding range 3900 ± 100 j/kg.°C Difference in specific heat capacity, C, from 100 to 400 is acceptable giving that Salt water has lower specific heat capacity, C.

Points: 1.0 pt

H. Based on your findings from the above method (thermodynamics), confirm the correct identity of samples PHYS-A and PHYS-B. Put a check mark (√) in front of the correct choice.

	Method 1 (Optics) 0.25 pt.		Method 2 (Thermodynamics) 0.75 pt.	
Seawater	PHYS-A	**PHYS-B**	PHYS-A	**PHYS-B**
Desalinated water	**PHYS-A**	PHYS-B	**PHYS-A**	PHYS-B

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Total points for thermodynamics.	
Total points for TASK TWO	
Signature	Scorer:
	Reviewer:
	Table leader:

Task 3: Chemistry - Determination of Water Hardness

Chemistry Question

Record your measurements in Table 6:

Points 2.25 pts

Table 6. Determination of total hardness of water sample # CHEM-A.

	Trial 1	Trial 2	Trial 3
Volume of water sample (mL) *0.25 each run total 0.75 pt for reporting 10.0 mL not 40.0 mL to the correct SF for all trials. (0.25 for each run)*	10.0	10.0	10.0
Initial volume of EDTA solution (V_i, mL)			
Final volume of EDTA solution (V_f, mL)			
Change in the volume of EDTA solution (ΔV, mL) 0.50 pt each for recording ΔV to 1 or 2 decimal places and for all runs (-0.25 pt for 1 incorrect recording of volume).			

Points: 0.25 pt

A. Calculate the average volume of EDTA solution (mL) used.

Average volume of EDTA solution used (mL) =

0.25 pt on calculation of Average Volume

Points: 0.50 pt (5 pts for precision and 5 pts for accuracy)

Total 10.50 pts

B. Calculate the % relative standard deviation (%RSD) for the volume of EDTA solution (mL) recorded in Table 6, knowing that *%RSD = **(S*100)/average.***

Report your answer as Average ± %RSD.

0.25 pt on calculation of %RSD + 0.25 pt on appropriately reporting the error.

%RSD of three titrations: Total 5 pt

- 5 points if %RSD < 0.5%
- 4 points if %RSD 0.5% - < 1.0%
- 3 points for %RSD 1.0 - <2.0%
- 2 points for %RSD 1.5 - <2.0%
- 1 point for %RSD 2.0 - 3.0%
- 0 point for %RSD >3.0%

Deviation from "real" value (%Relative Error by volume, **%RE**): Total 5 pt

- 5 point if %RE if %RE <1.0%
- 4 point for %RE 1.0 - <2.0%
- 3 points for %RE 2.0 - <3.0%
- 2 points for %RE 3.0 - <4.0%
- 1 point for %RE 4.0 - <5.0%
- 0 point for %RE >5.0%

Points: 1.25 pts	C. Using the **average** volume of EDTA solution you reported in Table 6, calculate the hardness of Sample CHEM-A. Show detailed calculations in the space provided below: C1. Moles of EDTA = 0.25 pt C2. Moles of Ca^{2+} in the sample = 0.25 pt C3. Moles of Ca^{2+} per litre = 0.25 pt C4. Mass (g) of $CaCO_3$ in 1 litre = 0.25 pt C5. Water Hardness (ppm) using the formula under the Principle section = 0.25 pt Calculations: Moles of Ca^{2+} in the sample = Moles EDTA = (M x V) EDTA Moles Ca^{2+} per liter = $mole\ of$ Ca^{2+} × $(1L)/$ $volume\ of$ sample (0.01 L) Grams $CaCO_3$ per liter = Moles Ca^{2+} x molar mass of $CaCO_3$ g/mol Water Hardness (ppm), mg $CaCO_3$ / liter sample using formula provided under procedure section

Points: 0.25 pts	D. Using the water hardness scale in Table 5, identify the type of water – Sample CHEM-A. Tick the appropriate box. 0.25 pt ☐ Soft ☐ Moderately soft ☐ Slightly hard ☐ Moderately hard ☐ Hard ☐ Very hard

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Total points for TASK THREE	
Signature	Scorer:
	Reviewer:
	Table leader:

	Student 1	Student 2	Student 3
Name			
Signature			