Appendix 12a

REVIEW

of dissertation for the acquisition of:

educational and scientific degree " **doctor** "	**X**
scientific degree **"Doctor of Science"**	
	the true is indicated by the sign "X"

Author of the dissertation:

		Eduard	**Lyudmilov**	**Stefanov**	
academic position	scientific degree	name	middle name	last name	workplace

Topic of the dissertation:

Speciation analysis of arsenic in copper electrolyte, waters and soils

Scientific area:

4	Natural Sciences, mathematics, and informatics
code	name

Professional area:

4.2.	Chemical Sciences
code	name

Scientific specialty:

Analytical Chemistry

The review was written by:

Professor	**PhD**	**Petar**	**Todorov**	**Todorov**	**UCTM - Sofia**
academic position	scientific degree	name	middle name	last name	workplace

1. Completion of the provided documents:

A) The dissertation and the competition documents are in full compliance with the Regulations.	4 points	**X**
B) The documents are complete but do not fully comply with the requirements of the Regulations.	2 points	
C) The documents are not completed in accordance with the requirements of the Regulations.	0 points	
		one of the answers given is marked with the

		sign "X"

Missing documents and violated standards must be described if response C is marked.
The submitted documents and materials of the competition fully comply with the Regulations.

2. Meeting the minimum requirements under the Regulations:

A) The candidate meets the minimum requirements	20 points	**X**
B) The candidate doesn't meet the minimum requirements	0 points	
		one of the answers given is marked with the sign "X"

It must be filled in if answer B is marked. The publication activity of the candidate is analyzed. The response of the results achieved (quoted) is analyzed.
The presented materials and results fully comply with the requirements of the Act for the development of the academic staff in the Republic of Bulgaria and the Regulations for its implementation, as well as those of UCTM-Sofia. The presented results were published in 4 scientific articles, 2 of them in *Archives of Metallurgy and Materials* with IF=0.6 and Q4 /12 points/, 1 publication in *Journal of Chemical Technology & Metallurgy* without impact factor, but with SJR /10 points/ and 1 publication in *Science, Engineering & Education* without IF and SJR. A quote was noticed on one of the publication. PhD-student Eduard Stefanov has taken an active part in 3 scientific forums with poster presentations and reports on the topic of her dissertation. Indicator G (publications in journals referenced in Scopus or Web of Science) is completed with 34 points /2 scientific publications in Q4 and one with SJR/, with a minimum of 30 points required.

3. The relevance of the topic of the dissertation:

A) The topic is relevant and new (there are no known results on the topic by other authors)	8 points	
B) The topic is relevant and results from other authors are known	6 points	**X**
C) The topic is not relevant, but results from other authors are known	2 points	
D) The topic is not relevant and no results from other authors are known	1 point	
E) The topic does not correspond to the level of dissertation	0 points	
		one of the answers given is marked with the sign "X"

The evaluation of the relevance of the dissertation must be substantiated
The PhD thesis covers the development of analytical methods for determining the forms of arsenic in materials and semi-products used in copper manufacturing. Arsenic is a particularly relevant topic these days because it is directly related to ecology and environmental protection, as well as the tightening of environmental regulations and the challenges associated with processing increasingly complex raw materials in the chemical and metallurgical industries.

4. Knowledge of the problems, subject of research in the dissertation:

A) The doctoral student knows in detail the achievements of other authors on the topic of the dissertation	8 points	**X**
B) The doctoral student is partially familiar with the achieved results on the topic of the dissertation	4 points	
C) The doctoral student has no prior knowledge of the status of the problems in the dissertation	0 points	
		one of the answers given is marked with the sign "X"

The evaluation must be substantiated if answer C is marked.
From the whole exposition, it is clear that the PhD-student Eduard Stefanov has gotten acquainted in detail with the scientific literature on the topic and is fluent in it.

5. Type of research:

A) Theoretical	4 points	
B) Applied	4 points	**X**
C) Theoretical with application elements	4 points	
D) It does not correspond to the level of dissertation	0 points	
		one of the answers given is marked with the sign "X"

The level of research must be substantiated if answer D is marked.
The PhD thesis focuses on arsenic speciation analysis in samples with various matrix compositions. Two of the developed procedures have been implemented in the laboratory practice of "Aurubis Bulgaria" AD. Thus, the research can be classified as completely applied.

6. Objectives of the research:

A) Realistic and of scientific and / or applied interest	8 points	**X**
B) Realistic, but not of scientific and / or applied interest	3 points	
C) Unattainable (unrealistic)	0 points	
		one of the answers given is marked with the sign "X"

Objectives must be specified. The type of the set objectives must be justified.
From the literature review, it is clear that PhD-student Eduard Stefanov is very well acquainted with the scientific literature on the topic and is fluent in it. Based on this, the purpose of the dissertation is formulated precisely and clearly and the respective 5 tasks for implementation are defined. The set goals of the conducted research are realistic, and the results achieved on their basis have a significant

scientific and applied interest.

7.Methods of research:

A) Adequate to research and set objectives	8 points	**X**
B) Partially appropriate, enabling part of the scientific objectives and / or applications to be achieved	4 points	
C) Inappropriate methods	0 points	
		one of the answers given is marked with the sign "X"

Methods must be specified. The type of methods used is justified.
During the development of his dissertation work, the doctoral student used some of the most modern methods for the analysis of inorganic forms of arsenic in various contaminated samples (water, soil, electrolytes). Particular attention is paid to liquid-liquid extraction, inductively coupled plasma optical emission spectrometry (ICP-OES), as well as ion chromatography. The provided results show that Eduard Stefanov is well-versed in a variety of analytical methodologies and procedures for analyzing arsenic in samples with varying matrix compositions. Arsenic speciation analysis is also being utilized more frequently in environmental monitoring, food regulation, and human health, as well as to optimize some chemical and metallurgical manufacturing processes.

8. Contributions of the dissertation:

A) With lasting scientific and / or applied response, they form the basis for new research and applications	20 points	**X**
B) They are of significant scientific and / or applied interest, complete and / or summarize previous research	16 points	
C) They are of scientific and / or applied interest	12 points	
D) Lack of significant contributions	8 points	
E) Lack of contributions	0 points	
		one of the answers given is marked with the sign "X"

Contributions must be specified. The type of results achieved must be justified.
The contributions to the dissertation are precisely and clearly formulated, and can be summarized as follows: 1. A total of 4 methods have been developed for speciation analysis of arsenic in samples with different matrix composition: -ICP-OES method in combination with liquid-liquid extraction for simultaneous determination of inorganic forms of arsenic in copper electrolyte; -ICP-MS method with liquid-liquid extraction to determine the forms of arsenic in wastewater; -ICP-MS method in combination with MW dissolution and liquid-liquid extraction for determination of inorganic forms of arsenic in contaminated soils; - an innovative and green ion-chromatographic method with conductometric detection for the direct

determination of As(V) and total As in copper electrolyte. 2. Two of the developed methods have been implemented in the laboratory practice of "Aurubis Bulgaria" JSC: - ICP-OES method in combination with liquid-liquid extraction for simultaneous determination of inorganic forms of arsenic in copper electrolyte; - ICP-MS method with liquid-liquid extraction to determine the forms of arsenic in wastewater. 3. Some steps in the wastewater treatment process at "Aurubis Bulgaria" JSC were optimized. A new approach to arsenic wastewater treatment have been tested: arsenic precipitation as crystalline scorodite $FeAsO_4.2H_2O$. Based on the precipitation of arsenic in the form of scorodite, "Aurubis Bulgaria" AD designed and launched the reconstruction of the industrial wastewater treatment plant, which would contribute to the region's long-term development by extending the operational period of the hazardous waste landfill.

9. Evaluation of the compliance of the dissertation summary with the dissertation:

A) Full compliance	4 points	**X**
B) Compliance of the main parts	2 points	
C) Lack of compliance of the main parts	0 points	
		one of the answers given is marked with the sign "X"

The evaluation must be substantiated if answer C is marked.
The dissertation summary meets the requirements of the Regulations of UCTM-Sofia and fully reflects the results of the research.

10. Participation of the doctoral student in the achievement of the results of the dissertation:

A) The doctoral student has at least an equal participation	8 points	**X**
B) The doctoral student has secondary participation	5 points	
C) The participation of the doctoral student is unnoticeable	0 points	
		one of the answers given is marked with the sign "X"

Critical notes must be provided if one of the items B or C is marked.
The presented dissertation work is completely dissertationable, with a real contribution to science and practice in a very important and increasingly sought-after field, such as analytical chemistry, in particular speciation analysis. The acquired results are up to date and have great practical value. Of the presented 4 publications on the topic of the dissertation, the doctoral student is the first author in 3 and the second author in 1 of them, which unequivocally shows his active participation in achieving the results in the dissertation work.

11. Critical notes:

A) Lack of critical notes	8 points	**X**

B) Critical notes of a technical nature	7 points	
C) Critical notes that would partially improve the results achieved	4 points	
D) Significant critical notes	0 points	
		one of the answers given is marked with the sign "X"

Critical notes must be provided if one of the answers C or D is marked.
The PhD thesis is written in a comprehensible manner, with a logical order to the exposition and summary of the results. There are minor stylistic and technical errors, but they do not detract from the enormous amount of results obtained.

12. Conclusion

A) The evaluation of the dissertation is **POSITIVE**	This evaluation is assigned to a total number of at least 65 points	**X** **(98 points)**
B) The evaluation of the dissertation is **NEGATIVE**	This evaluation is assigned to a total number below 65 points	
		one of the answers given is marked with the sign "X"

To be filled in at the request of the reviewer
Based on the above arguments in my review, I confidently vote "**positive**" assessment of the dissertation of Eduard Stefanov and recommend the esteemed members of the scientific jury to support her award of the educational and scientific degree "Doctor" in the scientific area 4.2. Chemical Sciences (Analytical Chemistry).

30.05.2024	The review was written by:	
date	**Professor PhD Petar Todorov**	signature