

	BQA NCQF QUALIFICATION TEMPLATE	Document No.	DNCQF.P01.GD02
		Issue No.	01
		Effective Date	01.08.2022

SECTION A: QUALIFICATION DETAILS														
QUALIFICATION DEVELOPER (S)		Botswana International University of Science and Technology (BIUST)												
TITLE	Master of Science in Pure and Applied Chemistry										NCQF LEVEL		9	
STRANDS (where applicable)	1. 2. N/A 3. 4.													
FIELD	Natural, Mathematical and Life Sciences			SUB-FIELD			Physical Sciences			CREDIT VALUE			240	
New Qualification							√	Legacy Qualification						
SUB-FRAMEWORK		General Education			√	TVET			√	Higher Education			√	
QUALIFICATION TYPE	Certificate	I	II	III	IV	V	Diploma	Bachelor or						
	Bachelor Honours			Post Graduate Certificate			Post Graduate Diploma							
	Masters					√	Doctorate/ PhD							
RATIONALE AND PURPOSE OF THE QUALIFICATION														
RATIONALE: The need for Chemists with a qualification in Master of Science in Chemistry in Botswana, the region and internationally has been indicated in various reports, surveys and documents. The Botswana Human Resources Development Council (Top Occupations in high Demand as at December 2016 and 2019) lists Science and Technology Researchers as being in demand in Botswana. The chemistry profession is also described as of short supply at medium level (Department of Research, Science and Technology 2009). According to the report, chemistry professionals are required in the mining, energy, agriculture and health sectors. Physical Scientists														

	BQA NCQF QUALIFICATION TEMPLATE	Document No.	DNCQF.P01.GD02
		Issue No.	01
		Effective Date	01.08.2022

and Physical Science Technicians are also in short supply in the education sector. Chemists are among the 42 professional categories enjoying scarce skill allowance in the civil service owing to their scarcity in Botswana. Chemists, including chemistry teachers enjoy the highest scarce skill allowance of 40% to basic salary and are categorized in the same bracket as medical doctors, dentists, engineers, architects, quantity surveyors, pharmacists. Laboratory chemist are also categorized as a profession with acute scarcity (Tsa Badiri Consultancy 2015).

Most of researchers in Botswana hold Bachelor's degrees as opposed to Masters and Doctorate degrees (DRST 2009). There is therefore need to upgrade Chemistry researchers to Honours, Masters and PhD levels. During the National Development Plan (NDP) 11 the Botswana Government will continue to grow the economy through beneficiation of minerals, various agricultural products and indigenous products/herbs. The proposed qualification will produce graduates with relevant skills to work in these sectors.

Chemistry is required to support other disciplines such as biology, engineering, pharmacy and medicine. The proposed qualification will help to diversify the economy as there is potential for growth in the chemical industry. This innovative industry will benefit from the skill set produced by the qualification. Botswana has the potential to develop fine chemicals and drugs. This could replace imported fuels and other chemicals. These activities require Chemistry which a bulk of it will be covered in this qualification.

The high demand for chemistry graduates applies regionally and internationally. The Republic of South Africa has a high demand for Research and Development Managers, Environmental Managers, Safety, Health, Environment and Quality Practitioners, Air Pollution Analyst, Water Quality Analyst, Physical Science Teachers, Natural Science Teachers, Chemistry Technicians, Physical Science Technicians, Forensic Technicians, Food and Beverage Technicians, Manufacturing Technicians and Water Inspectors (South Africa Government Gazette 2014). In the United states of America, the demand for Chemists and Chemical Technicians grew by 3.1% and 4.2%, respectively in 2014 (Rovner, 2014). Chemists are in demand in Australia (<http://www.visabureau.com/australia/anzsco/jobs/chemist-jobs-australia.aspx>). In Europe, shortages of Chemical Technicians are expected (C and E News, 93 issue 24, pp34-26, 2005). The proposed qualification is in line with vision 2036 as it will promote the following pillars (i) a knowledge based economy - the use of science, technology and innovation to propel economies to high levels of efficiency is key to supporting socio-economic development. (ii) promote human capital development-as the country will have developed an internationally competitive workforce that is productive and has international exposure and (iii) Education and skills development-Botswana society will be knowledgeable with relevant quality education that is outcome based, with an emphasis on technical and vocational skills as well as academic competencies and (iv) Ecosystem functions and services-providing research for the identification and development of marketable products. It will also produce chemists (and Chemical Technicians) for the region as well as the international community.

	BQA NCQF QUALIFICATION TEMPLATE	Document No.	DNCQF.P01.GD02
		Issue No.	01
		Effective Date	01.08.2022

PURPOSE: (itemise exit level outcomes)

The purpose of the Master of Science in Pure and Applied Chemistry qualification is to equip graduates with advanced knowledge, skills and competencies to:

- Embrace diverse perspectives to nurture innovation in Chemistry including sustainable and green technologies.
- Develop and use analytical, modelling, and spectroscopic techniques to solve problems such as the search for and analysis of chemicals.
- Use communication skills to communicate to a wider audience effectively and scientifically.
- Apply research skills to conduct applied research to address various problems involving Chemistry facing the country and the world at large working in multidisciplinary teams.

MINIMUM ENTRY REQUIREMENTS (including access and inclusion)

1. NCQF Level 7 –Bachelor of Science in Chemistry
2. Applicants who do not meet the above criteria but possess relevant industry experience may be considered through Recognition of Prior Learning (RPL) and Credit Accumulation and Transfer (CAT) policies for access. This consideration will be done following guidelines of the ETP which are aligned with BQA/National policies.

(Note: Please use Arial 11 font for completing the template)

	BQA NCQF QUALIFICATION TEMPLATE	Document No.	DNCQF.P01.GD02
		Issue No.	01
		Effective Date	01.08.2022

SECTION B QUALIFICATION SPECIFICATION	
GRADUATE PROFILE (LEARNING OUTCOMES)	ASSESSMENT CRITERIA
1. Apply advanced problem solving skills and application of chemistry in real life situations.	1.1. Evaluate chemistry literature to solve a problem chemistry encountered in industry 1.2. Create innovation for the application of chemistry concepts to solve problems. 1.3. Deduce and demonstrate that chemistry problem has been adequately solved using analytical techniques
2. Develop advanced digital skills in using library search tools	2.1. Use the library portal to access data bases in search for appropriate literature data such as for problem solving and innovation 2.2. Gather and interpret data in a research project in selected specialization of Chemistry 2.3. Select and use appropriate filters to gather specific and credible information
3. Analyze advanced chemistry knowledge in the characterization of materials and chemicals	3.1. Apply spectroscopic techniques for determination of material structure. 3.2. Apply analytical tools such as HPLC to purify and determine purity of materials and chemicals 3.3. Verify that the structure and purity of materials and compounds are correct 3.4. Apply specific techniques to determine the suitable application of materials and chemicals. 3.5. Choose appropriate techniques for the characterization of materials and compounds
4. Communicate the results of advanced academic field studies using main concepts, constructs and techniques to an audience	4.1. Use scientific language correctly to produce clear and coherent written research project document 4.2. Use appropriate referencing conventions, avoid plagiarism and observe intellectual property laws in written reports 4.3. Conduct seminar presentations topics in Chemistry to a wider audience 4.4. Formulate non-verbal forms of representation correctly and appropriately when representing structure in Chemistry.
5. Apply advanced scientific knowledge with core ethical virtues in resolving societal issues	5.1. Exercise sensitivity and confidentiality when dealing with sensitive information such as intellectual property 5.2. Take ethically and culturally sensitive decisions when dealing with sensitive data 5.3. Seek ethical clearance for research projects

	BQA NCQF QUALIFICATION TEMPLATE	Document No.	DNCQF.P01.GD02
		Issue No.	01
		Effective Date	01.08.2022

6. Apply advanced research methods to solve problems in Chemistry	6.1. Select appropriate chemistry methodologies, collect accurate and relevant data, evaluate recent literature, discuss and present the results. 6.2. Evaluate and critique current research practices and techniques in Chemistry 6.3. Compare the theoretical predictions with published data to evaluate the significance of the results in context. 6.4. Generalize the implications of the research project findings on the problem under consideration. 6.5. Analyze and draw conclusions on the results of an experiment 6.6. Propose recommendations related to the research problem
7. Apply advanced green technologies to solve problems in chemistry	7.1. Select appropriate green technologies, evaluate recent literature, discuss and present the results 7.2. Evaluate and critique current green technologies, their applications and 7.3. Propose recommendations related to green technologies for societal acceptance 7.4. Plan and conduct green technologies in the lab to create and refine innovative products in chemistry
8. Apply advanced research knowledge, skills and competence in a practical research project in Chemistry	8.1. Select a Chemistry project and use relevant research methodology to produce meaningful results. 8.2. Plan and conduct scientific experiments in the lab to create and refine innovative products in chemistry 8.3. Evaluate literature review on a selected research topic when writing a research report. 8.4. Analyze collected research data using appropriate statistical methods such as SPSS. 8.5. Discuss and present results in the form of a written report and oral presentation.

(Note: Please use Arial 11 font for completing the template)

 BOTSWANA Qualifications Authority	BQA NCQF QUALIFICATION TEMPLATE	Document No.	DNCQF.P01.GD02
		Issue No.	01
		Effective Date	01.08.2022

SECTION C		QUALIFICATION STRUCTURE			
COMPONENT	TITLE	Credits Per Relevant NCQF Level			Total Credits
			Level [8]	Level [9]	
FUNDAMENTAL COMPONENT <i>Subjects/ Courses/ Modules/Units</i>					
CORE COMPONENT <i>Subjects/Courses/ Modules/Units</i>	Advanced Organic Chemistry			12	12
	Advanced Inorganic Chemistry			12	12
	Advanced Physical Chemistry			12	12
	Advanced Analytical Chemistry			12	12
	Advanced Research Methods			12	12
	Masters Dissertation			132	132
STRANDS/ SPECIALIZATION <i>Subjects/ Courses/ Modules/Units</i>		Credits Per Relevant NCQF Level			Total Credits
			Level [8]	Level [9]	
1.					
2.					

 BOTSWANA Qualifications Authority	BQA NCQF QUALIFICATION TEMPLATE	Document No.	DNCQF.P01.GD02
		Issue No.	01
		Effective Date	01.08.2022

Electives	Special Techniques in Inorganic Chemistry			12	12
	Advanced Solid State Chemistry			12	12
	Retrosynthetic Principles and Synthetic Applications			12	12
	Spectroscopy and Structure elucidation			12	12
	Advanced Chromatography			12	12
	Advanced Electroanalytical techniques			12	12
	Magnetic Resonance			12	12
	Advanced Chemical Kinetics			12	12
	Sustainability and Green Technologies			12	12

	BQA NCQF QUALIFICATION TEMPLATE	Document No.	DNCQF.P01.GD02
		Issue No.	01
		Effective Date	01.08.2022

SUMMARY OF CREDIT DISTRIBUTION FOR EACH COMPONENT PER NCQF LEVEL	
TOTAL CREDITS PER NCQF LEVEL	
NCQF Level	Credit Value
9	240
TOTAL CREDITS	240

Rules of Combination:
(Please Indicate combinations for the different constituent components of the qualification)

Credit Contribution for Core and Elective modules

Component	Credit
Core	192
Elective	48
Total	240

All core modules are compulsory. The learners are to select **four** modules from the list of **Nine** electives.

This qualification will have at least **240 credits** and take at least twenty four months to complete.

The credit combination for the qualification is from **108** taught module credits in the first 12 months and **132** credits from the research component in the second 12 months.

(Note: Please use Arial 11 font for completing the template)

	BQA NCQF QUALIFICATION TEMPLATE	Document No.	DNCQF.P01.GD02
		Issue No.	01
		Effective Date	01.08.2022

ASSESSMENT ARRANGEMENTS

Both Formative and Summative assessment will contribute in range of 40-60 % to modules final grade. Learners are required to complete and submit an MSc Thesis in the second year, which will be examined according to the ETP guidelines.

MODERATION ARRANGEMENTS

Moderators must be BQA or equivalent regulatory bodies registered and accredited. Internal and external moderation will be done in line with both institutional and national policies.

RECOGNITION OF PRIOR LEARNING

Candidates may submit evidence of prior learning and current competence and/or undergo appropriate forms of RPL assessment for the award of credits towards the qualification in accordance with applicable RPL policies and relevant national-level policy and legislative framework

CREDIT ACCUMULATION AND TRANSFER

Credit Accumulation and Transfer (CAT) will be applicable in awarding the qualification and it shall be carried out in accordance with the University and national-level CAT policies.

PROGRESSION PATHWAYS (LEARNING AND EMPLOYMENT)

This qualification is designed to facilitate vertical and horizontal progression both locally and internationally.

○ Horizontal Progression

Graduates may progress horizontally to the following programmes:

- Master of Science in Organic Chemistry
- Master of Science in Materials Chemistry
- Master of Science in Environmental and Analytical Chemistry
- Master of Science in Physical Chemistry
- Master of Science in Inorganic Chemistry
- Master of Science in Medicinal Chemistry
- Master of Science in Pharmaceutical Science
- Master of Business Administration
- Master of Project Management

○ Vertical Progression

	BQA NCQF QUALIFICATION TEMPLATE	Document No.	DNCQF.P01.GD02
		Issue No.	01
		Effective Date	01.08.2022

Graduates may progress vertically to level 10 qualifications:

- Doctor of Philosophy in Organic Chemistry
- Doctor of Philosophy in Materials Chemistry
- Doctor of Philosophy in Environmental and Analytical Chemistry
- Doctor of Philosophy in Physical Chemistry
- Doctor of Philosophy in Inorganic Chemistry
- Doctor of Philosophy in Medicinal Chemistry
- Doctor of Philosophy in Pharmaceutical Science

○ **Employment pathways**

Graduates of the qualification may find employment in a range of public and private organisations. Typical roles include:

- Quality control
- Site Chemist
- Materials Chemist
- Medicinal Chemist
- Research and development Chemist
- Development Chemist
- Synthetic Organic Chemistry
- Water Chemists
- Soil Scientists
- Chemical Technicians
- Research Technicians
- Science and Technology Researchers
- Safety, Health, Environment and Quality Practitioners
- Food and Beverage Technicians
- Quality Assurance Technician in Manufacturing Processes
- Water Inspectors

QUALIFICATION AWARD AND CERTIFICATION

A candidate will be awarded a qualification in Master of Science in Pure and Applied Chemistry upon meeting the minimum of 240 credits as prescribed in the rules of combination.

A Certificate and Transcript will be issued to graduates upon successful completion of Master of Science in Pure and Applied Chemistry.

SUMMARY OF REGIONAL AND INTERNATIONAL COMPARABILITY

University of Botswana- MSc in Chemistry; Level 9

	BQA NCQF QUALIFICATION TEMPLATE	Document No.	DNCQF.P01.GD02
		Issue No.	01
		Effective Date	01.08.2022

MSc in chemistry are by coursework and dissertation, extending over two years-fulltime. Admission is BSc in Chemistry or equivalent. The coursework is conducted during the first academic year with 24 credits in the core and specialization course. The supervised original research project is in the second year of study, The specialization is determined in conjunction with the supervisor of the MSc in Chemistry project.

University of Limpopo, MSc in Chemistry-Level 9

The program admits BSc and BSc Honours in Chemistry, The module is a 2 year research project based.

Merrimack College, USA, MSc in Applied Chemistry

The USA currently does not have NQF, but the MSc in applied Chemistry structure consist of course work and research work. The program admits BSc and BSc Honours in Chemistry. The advanced electives rotate traditional chemical themes: Analytical, Biochemistry, Inorganic, Organic and Physical. One notable feature is that learners can “opt out” of the research component by taking alternative graduate courses in chemistry.

University of Liverpool, MSc in Chemistry -Level 7

A fulltime 1 year MSc in chemistry, admitting BSc honours (FHEQ level 6). Students take 90 credits of advanced chemistry modules. Introduction to Research, tailored to suit their particular background and research area. And finally a research project working in an active research group within one of the main research areas of the Department.

University College London, UK, MSc in Applied Analytical Chemistry-level 7

A fulltime FHEQ level 7 qualification of 180 credits with course work and research work. Assessment is by presentations, vivas, and problem-solving coursework. There are no written exams for this programme. The literature project is assessed by written dissertation. The research project is assessed by a written report, supervisor appraisal, an interim oral presentation with viva voce and poster presentation. Degree is accredited by the Royal Society of Chemistry for quality assurance.

Maria Curie-Skłodowska University (MCSU), Poland, MSc in Chemistry, (major: pure and applied chemistry)-level 7

A two year MSc with 120 ECTS credits structured into a course work and material science specialized project.

Al-Azhar College of Arts & Science, India, Master of Science (Branch III -Pure Chemistry)

Two year Master program, eligible for students with BSc in Chemistry. The modules were not specified.

Technical University of Denmark, MSc in Applied Chemistry-Level 7

	BQA NCQF QUALIFICATION TEMPLATE	Document No.	DNCQF.P01.GD02
		Issue No.	01
		Effective Date	01.08.2022

A fulltime 2 year MSc in Applied chemistry. Students take 40 credits of General competency modules and 50 credits from a selection of technological specialization courses and finally 30 ECTS credits of Master of Science Thesis. The research project is selected from the research areas of the Department.

Comparability and articulation of the proposed qualification with the ones examined

Desktop research was conducted to identify international qualifications which were comparable or have the components of “Pure Chemistry” and “Applied Chemistry” which combines to form the proposed qualification.

The qualifications from United State of America, United Kingdom, Denmark, Poland, India and South Africa were surveyed. The qualifications showed the advanced knowledge and practical goals or applications that should be covered by the proposed qualification. The Polish, Maria Curie-Skłodowska University (MCSU), Poland, MSc in Chemistry, (major: pure and applied chemistry) was the only qualification which had an identical name to proposed qualification. The common qualification structure is one year of advanced course work and one year advanced research project work in a two year duration.

The MSc Thesis research project was aligned to country/university/departmental research focus areas. There are both fulltime and part-time offers of MSc degree. The successful examination of the research project was a key component to awarding an MSc degree. Thus, the proposed qualification generally compared well with the European and American Chemistry qualifications at Master’s level in terms of content, scope, learning outcomes and hours/credits to be achieved before assessment. The assessment assesses the ability to analyze advanced concepts, synthesize whole ideas and concepts, and to evaluate the value of advanced concepts, prepare and communicate an advanced research project report.

The developed qualification offers equal opportunities for further studies and employment compared with the benchmarked qualifications

REVIEW PERIOD

Review period is 5 Years and as and when the need arises.

(Note: Please use Arial 11 font for completing the template)