QUALIFICATION SPECIFICATION SECTION A						
QUALIFICATION DEVELOPER	Botswana International University of Science and Technology					
TITLE	Bachelor of Science in Chemistry (Materials and Applied Chemistry)			**NCQF LEVEL**	7	
FIELD	Natural, Mathematical and Life Sciences		**SUB-FIELD**	Materials and Applied Chemistry		
New qualification	✓	Review of existing qualification				
SUB-FRAMEWORK	General Education		TVET		Higher Education	✓
QUALIFICATION TYPE	Certificate		Diploma		Bachelor	✓
	Bachelor Honours		Master		Doctor	
CREDIT VALUE 522						

1. RATIONALE AND PURPOSE OF THE QUALIFICATION

Rationale of the qualification

The need for Materials and Applied Chemists in Botswana, the region and internationally has been indicated in various reports, surveys and documents. Materials chemistry is an exciting area to be involved in, as new discoveries such as nanomaterials or new functional materials, have the capacity to make major and immediate contributions to society. The Botswana Human Resources Development Council (Top Occupations in high Demand as at December 2016) lists Science and Technology Researchers, Water Chemists and Chemical Technicians 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 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 chemists are also categorized as a profession with acute scarcity (Tsa Badiri Consultancy 2015). 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 programme 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 programme will help to diversify the economy as there is potential for growth in the manufacturing industry. Botswana as a cattle country has potential for vibrant soap and leather industries. In addition to this, Botswana can also convert its huge supply of coal into high value petroleum and chemical products. This could replace imported fuels and other chemicals. These activities require Applied Chemistry.

The high demand for chemistry graduates applies regionally and internationally. The Republic of South Africa has a high demand for Environmental analysts and researchers. Other area of high demand in South Africa which rely on the Chemists include 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). Chemists are also required in the oil sector as 11 African countries have proven oil reserves (https://www.sablog.kpmg.co.za/2014/04/african-chemical-industry-hidden-opportunity/). 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 qualification and programme to offered 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.

Purpose of the qualification

The purpose of Bachelor of Science in Chemistry (Materials and Applied Chemistry) is to produce graduates who can:

- Develop and synthesize new materials and subsequent processes.
- Apply advanced research at industrial levels to improve life.
- Apply research skills to conduct applied research to address various materials science problems involving applied chemistry facing the country and the world at large working in multidisciplinary teams.

2. ENTRY REQUIREMENTS (including access and inclusion)

•Minimum entry qualification:
Certificate IV, NCQF Level 4

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

QUALIFICATION SPECIFICATION	SECTION B
3. GRADUATE PROFILE (EXIT LEARNING OUTCOMES)	**ASSESSMENT CRITERIA**
3.1 Apply advanced Chemistry concepts in the analysis of materials	3.1.1 Demonstrate comprehensive understanding of applied chemistry literature knowledge in strengthening or combining materials or developing new materials for applications such as diagnostics. 3.1.2 Use knowledge understanding for critical assessment of a wide range of ideas and problems in the field of applied chemistry when developing new materials such as ceramics.
3.2 Demonstrate the use of specialized knowledge of applied science in the characterization of materials	3.2.1 Use appropriate analytical tools to determine properties of materials such as strength and mechanical properties. 3.2.2 Use specific techniques to determine the suitable application of materials such as energy storage and filtration.
3.3 Use evidence based comparative chemistry approach when analyzing and synthesizing materials	3.3.1 Resolve materials properties for specialized applications such as energy storage and filtration. 3.3.2 Apply green chemistry initiatives in synthesis of new materials.
3.4 Communicate the results of specialized academic field studies using main concepts, constructs and techniques to audience	3.4.1 Use scientific language correctly to produce clear and coherent written laboratory and research reports. 3.4.2 Use appropriate referencing conventions avoid plagiarism and observe intellectual property laws in written reports 3.4.3 Conduct seminar presentations to a wider audience 3.4.3 Attend and contribute to internal and external project meetings
3.5 Employ specialized problem-solving skills relating to qualitative	3.5.1 Analyze qualitative and quantitative scientific data in familiar and unfamiliar contexts for materials development.

and quantitative data in Materials and Applied Chemistry	3.5.2 Integrate data analysis results in solving identified problems such as processes of materials development.
3.6 Work effectively as a member of a team in Materials and Applied Chemistry projects and investigation studies	3.6.1 Contribute effectively and meaningfully to group work in teamwork assignments. 3.6.2 Apply organizational skills in managing teamwork.
3.7 Apply advanced scientific knowledge with core ethical virtues in resolving societal issues	3.7.1 Demonstrate sensitivity when dealing with confidential analyzed data in new materials development and processes. 3.7.2 Take ethically and culturally sensitive decisions when dealing with sensitive data.
3.8 Apply appropriate research methods to solve problems in search for development of new materials and processes	3.8.1 Select appropriate chemistry methodologies, collect accurate and relevant data, evaluate recent literature and discuss and present the results. 3.8.2 Evaluate and critique current research practices and techniques in materials development. 3.8.3 Compare theoretical predictions with published data to evaluate the significance of the results in context. 3.8.4 Explain implications of the research project findings on the problem under consideration. 3.8.5 Analyze and draw conclusions on the results of an experiment. 3.8.6 Propose recommendations related to the research problem.
3.9 Apply specialized research knowledge, skills and competence in a practical research project aligned to Materials and Applied Chemistry	3.9.1 Select a Materials and Applied Chemistry project and use relevant research methodology to produce meaningful results. 3.9.2 Evaluate literature review on a selected research topic when writing a research report. 3.9.3 Analyze collected research data using appropriate analytical tools such as electron microscopy. 3.9.4 Discuss and present results in the form of a written report and oral presentation to clients and stakeholders.

4. QUALIFICATION STRUCTURE

SECTION C

	Title	Level	Credits
FUNDAMENTAL COMPONENT Subjects / Units / Modules /Courses	General Chemistry I	5	12
	General Chemistry II	6	12
	General Biology I	5	12
	General Biology II	6	12
	General Physics	5	24
	Pre-Calculus	5	24
	Introduction to Computing	5	12
	Academic Literacy Skills	5	12
	Technical Report Writing	6	12
	Business and Entrepreneurship	7	24
CORE COMPONENT Subjects / Units / Modules /Courses			
	Introductory Organic, Analytical, Inorganic and Physical Chemistry	6	48
	Calculus	6	36
	Statistics	6	12
	Introductory principles of Materials Science	6	36
	Applied Analytical, Inorganic and Physical Chemistry	7	108
	Materials Chemistry	7	84
	Work based Learning	7	24
	Research Methods and Project	7	18
ELECTIVE COMPONENT Subjects / Units / Modules /Courses			
	Total		**522**

4.1 Rules of combinations, Credit distribution (where applicable):

Table 1. Credit Distribution

NCQF Level	Credit Contribution
Level 5	96
Level 6	156
Level 7	270
Total Credits	522

Table 2. Credit Contribution for Fundamental and Core modules

Component	Credit Contribution
Fundamental modules	96
Core modules	426
Total Credits	522

5. ASSESSMENT AND MODERATION ARRANGEMENTS

Formative Assessment

Formative assessment contributes 50% towards final grade.

Summative Assessment

Summative assessment contributes 50% of the final grade.

Assessors must be BQA registered and accredited

Moderation Arrangements

Moderators must be BQA registered and accredited. Internal and external moderation will be done in line with both institutional and national policies as a quality assurance process.

6. RECOGNITION OF PRIOR LEARNING (if applicable)

Recognition of Prior Learning (RPL) will be applicable for award of this qualification in accordance with relevant RPL principles and common practices. It will be implemented in accordance with the relevant national RPL guiding instruments such as National Policies and/or guidelines

Credit Accumulation and Transfer system will also be implemented for this qualification to recognize previously acquired learning and attainment.

7. PROGRESSION PATHWAYS (LEARNING AND EMPLOYMENT)

Learning pathway

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

Horizontal Progression (NCQF Level 7)

Graduates of this qualification may consider pursuing related qualification for the purpose of multiskilling, retooling and to gain expert knowledge in Chemistry for Materials and Applied Chemistry. Credit transfer, module mapping and exemptions can be exercised in the following programmes:

- Bachelor of Science in Materials Science
- Bachelor of Science in Polymer Science
- Bachelor of Science in Chemistry (Materials and Nano Chemistry)
- Bachelor of Science in Chemistry (Environmental and Analytical Chemistry)
- Bachelor of Science Forensic Sciences

Vertical Progression (NCQF Level 8)

Students graduated from this qualification may progress to level 8 qualifications such as:

- Bachelor of Science Honours Materials Science
- Bachelor of Science Honours Polymer Science
- Bachelor of Science Honours Chemistry (Materials and Nano Chemistry)
- Bachelor of Science Honours Forensic Science

Employment pathways

The qualification will produce highly employable graduates with a broad background in academic chemistry and significant experience of the application of chemistry in contexts relevant to society and industry. Typical roles include:

- Site Chemist
- Materials Chemist
- Research and development Chemist
- Development Chemist

8. QUALIFICATION AWARD AND CERTIFICATION

A candidate will be awarded a qualification in Bachelor of Science in Chemistry (Materials and Applied Chemistry) upon meeting the minimum of 522 credits as prescribed in the rules of combination.

Certificate and transcript will be issued to graduates upon successful completion of Bachelor of Science in Chemistry (Materials and Applied Chemistry).

9. REGIONAL AND INTERNATIONAL COMPARABILITY

BSc in Chemistry with Materials from Heriot Watt University (Edinburgh) is offered under The Scotland Credit and Qualifications Framework, UK at level 9. This is a three (3) year program and aims to instil in students a sense of enthusiasm for chemistry, an appreciation of its application in different contexts and to involve them in an intellectually stimulating and satisfying experience of learning and studying. It provides students with a broad and balanced foundation of chemical knowledge and practical skills, and also the ability to apply their chemical/materials knowledge and skills to the solution of theoretical and practical problems in chemistry. Understanding, knowledge and subject-specific skills are assessed by a variety of means, such as web-based tests, coursework assignments, essays, unseen written examinations, laboratory reports, project work and presentations.

The McGill University in Australia offers BSc Chemistry – Materials under Ontario Qualifications Framework, Canada at level 10. This degree leads to a wide variety of professional vocations. The large science-based industries (petroleum refining, plastics, pharmaceuticals, etc.) all employ chemists in research, development, and quality control. Many federal and provincial departments and agencies employ chemists in research and testing laboratories. Such positions are expected to increase with the currently growing concern for the environment and for consumer protection. A background in chemistry is also useful as a basis for advanced study in other related fields, such as medicine and the biological sciences. For a business career, a B.Sc. in Chemistry can profitably be combined with a master's degree in Business Administration, or a study of law for work as a patent lawyer or forensic scientist.

Similar program is offered at the University of Wollongong under Australian Qualifications Framework, Australia at level 7. BSc Materials degree aims to provide the scientific knowledge and technical skills necessary for a successful materials-based career in areas such as quality control and laboratory testing, materials process control, and research and development in government and private sector laboratories. Core Materials subjects involve detailed study of the structure of properties of metals, ceramics and polymers.

The BSc in Chemistry (Materials and Applied Chemistry) compares well with international qualifications offered by Heriot Watt University (Scotland), McGill University (Canada), University of Wollongong (Australia) and University of Cape Town (South Africa) in terms of the comparisons of content scope and

learning outcomes hours to be achieved before assessment. These universities follow the guidelines required by the Royal Science of Chemistry and American Chemical Society Guidelines and Evaluation Procedures for bachelor's degree programmes. The United Kingdom Quality Assurance Agency for Higher Education's Chemistry benchmark has been followed as have the American Chemistry society's guidelines for bachelor's degree programmes in Chemistry.

10. REVIEW PERIOD

The review shall be done after 5 years as per cycle or as and when necessary.