SECTION A:	***QUALIFICATION DETAILS***																	
QUALIFICATION DEVELOPER (S)	Botswana International University of Science and Technology																	
TITLE	Doctor of Philosophy in Chemistry													***NCQF LEVEL***	10			
STRANDS (where applicable)	N/A.																	
FIELD	Natural, Mathematical and Life Sciences		***SUB-FIELD***	Physical Sciences										***CREDIT VALUE***	*360*			
New Qualification	✓													*Legacy Qualification*				
SUB-FRAMEWORK	*General Education*			*TVET*										*Higher Education*	✓			
QUALIFICATION TYPE	*Certificate*	*I*		*II*		*III*		*IV*		*V*		*Diploma*		*Bachelor*				
	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 Doctor of Philosophy 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 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).

Most researchers in Botswana hold Bachelors/Masters degrees as opposed to Doctorate degrees (DRST 2009). There is therefore a need to upgrade Chemistry researchers to 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 course.

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.

PURPOSE: (itemise exit level outcomes)

The purpose of this qualification is to produce graduates with most advanced knowledge, skills, and competences to;

- Contribute to the development of new knowledge at the most advanced level in the field of Chemistry through the development of new methods.
- Conduct independent research and lead data management and chemical analyses for varous research projects/studies.
- Lead research related to chemistry and in business or industry.

MINIMUM ENTRY REQUIREMENTS (including access and inclusion)

- Master's Degree (NCQF level 9) in the same or a cognate field of study
- 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) institutional policies in line with National RPL and CAT Policies for access.

SECTION B	***QUALIFICATION SPECIFICATION***
GRADUATE PROFILE (LEARNING OUTCOMES)	***ASSESSMENT CRITERIA***
1. Apply most advanced problem-solving skills and application of chemistry in real life situations of international standard.	**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. **1.4.** Apply highest level of specialized skills and techniques including critical analysis, evaluation, and synthesis of new and complex ideas to develop new knowledge and approaches
2. Develop most 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 most 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. Develop appropriate techniques for the characterization of materials and compounds
4. Communicate the results of 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 most 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.
6. Apply most advanced research methods to solve complex 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.** Extend and redefine existing knowledge and professional practice.

	6.6. Propose recommendations related to the research problem
7. Apply most advanced and specialized research knowledge, skills, and competence in a practical and theoretical research project in Chemistry.	**7.1.** Select a Chemistry project and use relevant research methodology to produce meaningful results. **7.2.** Develop, plan and conduct scientific experiments in the lab to create and refine new innovative products in chemistry. **7.3.** Evaluate literature review on a selected research topic when writing a research report. **7.4.** Develop and analyze collected research data using appropriate statistical packages or software such as SPSS. **7.5.** Develop and implement a strategy for dissemination of research findings in the form of a written report and oral presentation that can undergo a rigorous peer review process. **7.6.** Defend the research work and outputs before a diverse audience.

SECTION C	***QUALIFICATION STRUCTURE***				
COMPONENT	***TITLE***	***Credits Per Relevant NCQF Level***			***Total Credits***
		Level [10]	***Level [ ]***	***Level [ ]***	
FUNDAMENTAL COMPONENT *Subjects/ Courses/ Modules/Units*					
	N/A				
CORE COMPONENT *Subjects/Courses/ Modules/Units*	Thesis of Doctor of Philosophy Degree in Chemistry	*360*			***360***

STRANDS/ SPECIALIZATION	*Subjects/ Courses/ Modules/Units*	***Credits Per Relevant NCQF Level***			***Total Credits***
		Level [ ]	***Level [ ]***	***Level [ ]***	
1.	**N/A**				
2.					

SUMMARY OF CREDIT DISTRIBUTION FOR EACH COMPONENT PER NCQF LEVEL	
TOTAL CREDITS PER NCQF LEVEL	
NCQF Level	***Credit Value***
10	***360***
TOTAL CREDITS	***360***

Rules of Combination:

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

This qualification will have at least **360 credits** and take at least thirty-six months to complete.

The credit combination for the qualification is from **360 core components** that is based solely on research.

ASSESSMENT ARRANGEMENTS

There are no written examinations for PhD learners. However, learners are required to submit a concept note that will be evaluated by the department. After that, learners are required to defend a research proposal in order to be confirmed as PhD candidates. Learners are also required to show satisfactory progress from semester to semester. This is assessed through a progress report at the end of every semester. Learners are required to submit a PhD thesis which will be examined according to the ETP guidelines which are aligned with BQA/national guidelines on the same.

MODERATION ARRANGEMENTS

Internal and external moderation will be done according to the BIUST guidelines which are aligned with BQA/national guidelines on the same.

RECOGNITION OF PRIOR LEARNING

Recognition of prior learning shall be in line with the Institutional RPL Policy which itself is in line with the National RPL Policy.

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:

- 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

Vertical Progression

There are no qualifications to progress to vertically.

Employment pathways

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

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

QUALIFICATION AWARD AND CERTIFICATION

Qualification award: The students enrolled in the qualification will be able to obtain a Doctor of Philosophy in Chemistry. To obtain the Doctor of Philosophy in Chemistry the learner must complete at least 360 credits and defend their thesis.

Certification: Certificate and transcript will be issued to graduates upon successful completion of Doctor of Philosophy in Chemistry.

SUMMARY OF REGIONAL AND INTERNATIONAL COMPARABILITY

The qualification compares favorably with other similar degrees of Doctor of Philosophy qualifications, regionally and internationally around the world with regards to learning outcomes and assessment criteria, number of credits, structure and purposes.

The qualification was benchmarked with PhD qualification from the following Universities: University of Limpopo, University of Limerick, and University of Liverpool. The consulted PhD in Chemistry degree are similar to the proposed, whereby the PhD dissertation research project aligned to departmental research expertise is the integral component. There are either full-time or part-time offering of PhD degrees. The successful examination (both oral and written) of the research project is required for awarding of PhD degree. Thus, the proposed qualification generally compares well with the qualifications studied in terms of content, scope, learning outcomes and hours to be achieved before final assessment. The assessment assesses the ability to analyze concepts, synthesize whole ideas and concepts, and to evaluate the value of concepts, prepare and communicate a research project report. Two of the qualifications benchmarked against have 360 credits just like the developed one.

The developed qualification offers equal opportunities for further studies and employment compared with the benchmarked qualifications for instance the graduates of these qualifications qualify to advance their studies in Doctor of Philosophy in Physical Chemistry, Doctor of Philosophy in Organic Chemistry, Doctor of Philosophy in Medicinal Chemistry amongst others. Available work opportunities are medicinal chemist, soil chemist, chemist, Synthetic Organic Chemistry, food, and beverage chemists amongst others.

REVIEW PERIOD
Every five (5) years.