



January 4, 2018

James D. Fielder, Jr. Ph.D.  
Secretary of Higher Education  
Maryland Higher Education Commission  
6 North Liberty Street  
Baltimore, Maryland 21201

Dear Secretary Fielder:

Carroll Community College is requesting approval of a new Associate of Science degree in Physical Science, with Areas of Concentration in Chemistry, Geology and Physics. This new degree parallels the Associate of Science degree in Biology that was approved for Carroll by MHEC last year. This degree program provides direct transfer from Carroll Community College to Bachelor of Science degrees at four-year institutions across the state. This program was modeled on the first two years of Bachelor of Science degrees based on the transfer information provided in ARTSYS and through conversations with our articulation partners at various colleges and universities. Since most jobs in the sciences require a four-year degree, it is important for community colleges to provide a lower cost, high quality alternative for students to begin their college careers that ensure smooth transfer.

If you have any questions or need any further information, please contact me at [rmince@carrollcc.edu](mailto:rmince@carrollcc.edu) or 410-386-8195, or the Associate Vice President of Programs and Partnerships, Dr. Melody Moore at [memoore@carrollcc.edu](mailto:memoore@carrollcc.edu) or 410-386-8412.

Sincerely,

A handwritten signature in cursive script that reads 'Rosalie V. Mince'.

Rosalie V. Mince, Ph.D.  
Vice President of Academic and Student Affairs  
Carroll Community College

Cc: Dr. Melody Moore, Dr. Raza Khan, Ms. Laurie Shields, Dr. April Herring

MARYLAND HIGHER EDUCATION COMMISSION  
ACADEMIC PROGRAM PROPOSAL

**PROPOSAL FOR:**

- NEW INSTRUCTIONAL PROGRAM  
 SUBSTANTIAL EXPANSION/MAJOR MODIFICATION  
 COOPERATIVE DEGREE PROGRAM  
 WITHIN EXISTING RESOURCES or  REQUIRING NEW RESOURCES

*(For each proposed program, attach a separate cover page. For example, two cover pages would accompany a proposal for a degree program and a certificate program.)*

**Carroll Community College**

Institution Submitting Proposal

**Fall 2018**

Projected Implementation Date

**Associate of Science (A.S.)**

Award to be Offered

**Physical Science  
with Concentrations in Chemistry, Geology, and Physics**

Title of Proposed Program

**1901.00**

Suggested HEGIS Code

**40.0101**

Suggested CIP Code

**Division of Science**

Department of Proposed Program

**Raza Khan**

Name of Department Head

**Melody L. Moore**

Contact Name

**memoore@carrollcc.edu**

Contact E-Mail Address

**(410) 386-8412**

Contact Phone Number



Signature and Date

**1-3-18**

President/Chief Executive Approval

Date Endorsed/Approved by Governing Board

Date

## Physical Science A.S. Carroll Community College

### A. Centrality to institutional mission statement and planning priorities:

1. Provide a description of the program, including the degree to be awarded, each area of specialization/concentration (if applicable), purpose or objective, and how it relates to the institution's approved mission.

Carroll Community College's (CCC) mission is to be a "public, open admissions, associate-degree-granting college serving Carroll County, MD with baccalaureate preparation programs, career education, workforce and business development, and personal and cultural enrichment opportunities. As a vibrant, learner-centered community, the college engages students as active learners, prepares them for an increasingly diverse and changing world, and encourages their lifelong learning." This mission is conveyed through ten college goals, three of which are expressly addressed by the proposed *Associate of Science (A.S.) degree program in Physical Sciences with concentrations in Chemistry, Physics, and Geology*. Those three are:

*Goal 2: Provide opportunities for all learners to develop competencies in communications skills, critical thinking, quantitative and scientific reasoning, information and technological literacy, creativity, global awareness, and personal development.*

*Goal 3: Prepare students for completion of the baccalaureate degree through rigorous transfer programs, appropriate advising and support services, and effective articulation agreements.*

*Goal 4: Provide career preparation, job skill enhancement, continuing professional education, and career development services through credit and noncredit programs.*

The proposed A.S. degree program in Physical Sciences (with concentrations in chemistry, physics, and geology) seeks to meet the college's above goals of providing convenient and affordable baccalaureate preparation; of encouraging students to be full and active partners in their learning; of creating an environment supporting student and organizational learning; and assessing learning outcomes for the improvement of learning and instruction.

Through engaging lab, field, and classroom activities, the Science Division at CCC seeks to provide students with the current scientific knowledge and skills necessary to prepare them for their educational and career goals. The major goal of all courses in the biological and physical sciences is to involve the student actively in the use and understanding of the scientific method, using a variety of instructional modes such as technology, analysis and interpretation of data, oral and written communication, information literacy, problem solving, and critical thinking skills.

The A.S. degree in Physical Sciences will prepare students for further study or entry-level positions. In addition to the regional and national need for well-prepared physical science professionals in a wide range of professional settings, this program offers concentration choices of chemistry, physics, and geology for students entering into college already certain of their career path. Opportunities in physical science are growing regionally and represent a state-wide initiative to grow the life science career options and keep highly talented professionals within the state. This

program for CCC as it will allow students to meet personal career academic goals, as well as contribute to a strong talent pool for state-level commerce needs.

According to STEM education research, when colleges provide students with the knowledge and tools to declare a major sooner in their career, students take fewer unnecessary credits. Students who transfer successfully into STEM fields take a majority of STEM courses during their first semester on campus.

The development of the AS in Physical Science will allow students who might otherwise have declared a General Studies major to focus their coursework in Physical Science disciplines during their first semester on campus.

At the College, General Studies has traditionally been the major with the largest number of students, and while there will always be a population of students for whom that degree is appropriate, the college will begin encouraging students to declare a "meta" or "umbrella" area of study in a more specific content area. This initiative will be supported by faculty advising and degree-focused co-curricular events and transfer advising.

2. Explain how the proposed program supports the institution's strategic goals and provide evidence that affirms it is an institutional priority.

The A.S. degree in Physical Sciences directly supports three initiatives of CCC's current Strategic Plan:

*I-1 Program Completion: Analyze correlates of success and adopt best practices to support student degree, program, and credential completion.*

The A.S. degree in Physical Sciences (with concentrations in Chemistry, Geology and Physics) gives serious science students the encouragement to complete their two-year degree rather than transferring to a four-year institution after only a semester or two of study. Though an Associate of Arts (A.A.) degree would also prepare science students for baccalaureate transfer, many of the more focused science students' perceptions of the worth of an A.S. degree over an A.A. degree becomes a strong motivator for degree completion. Since they place lower value on an A.A. degree, they frequently transfer part way through their program of study rather than completing the A.A. degree.

*I-2 Areas of Study, Pathways, and Student Academic Planning: Implement the Areas of Study, Academic Pathways, and Student Planning initiative to promote recruitment and retention.*

There currently exists an A.S. in Biology degree program at CCC. An A.S. Physical Sciences degree program will offer high school STEM students another an A.S. degree option at CCC with concentrations in chemistry, physics and geology.

*II-1 Five-year Academic and CET Instructional Programming Plan: Identify current programs for enhanced development, and new instructional programs to launch over the next five years.*

The development of an A.S. Physical Science degree program with concentrations in Chemistry, Geology and Physics is in direct accordance with this initiative. This program will directly support

the mission of CCC by helping students prepare for a baccalaureate program. The program is designed to reduce the time-to-degree for students who typically select the General Studies major by enabling students who are interested in Physical Science to start on a more focused curricular pathway their first semester on campus.

These initiatives align with the following CCC 2020 Strategic Goals:

- a. Enhance student persistence, success, and completion through collaborative and effective support systems - students concentrating in Chemistry, Geology or Physics will have a focused curriculum to follow rather than a suggested pathway. This will reduce the likelihood that students register for coursework that is not necessary to graduate.
- b. Increase access, affordability, and student goal completion-research shows that students are more likely to graduate when their program of study is focused;
- c. Promote excellence in the design, delivery, and support of student learning-targeted advising, co-curricular events around the broad majors, and more will create communities of learners.

**B. Adequacy of curriculum design and delivery to related learning outcomes consistent with Regulation .10 of this chapter:**

1. Provide a list of courses with title, semester credit hours and course descriptions, along with a description of program requirements.

See Appendix A for course descriptions and Appendix B for supporting courses that satisfy General Education requirements.

*Below are listed the Core Courses and three areas of concentration for the AS in Physical Sciences.*

<u>Core Courses</u>	
<b>English</b>	
ENGL 101 College Writing	3
ENGL 102 Writing about Literature	3
<b>Mathematics</b>	
MATH 135 Calculus of a Single Variable	4
<b>Science</b>	
CHEM 105 General Chemistry 1	4
CHEM 106 General Chemistry 2	4
<b>Arts and Humanities</b>	
Social and Behavioral Sciences	6
30	

<u>Chemistry Concentration</u>	
CHEM 201 Organic Chemistry 1	5

CHEM 202 Organic Chemistry 2	5
MATH 136 Calculus of a Single Variable 2	4
PHYS 101/111	4
PHYS 102/212	4
BIOL 101	4
Electives	4
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<b><u>Geology Concentration</u></b>	
GEOSC 121 Physical Geology	4
GEOSC 123 Historical Geology	4
GEOSC 103 Environmental Sustainability	3
GEOSC 110 Physical Geography	4
PHYS 101/PHYS 111	4
PHYS 102/PHYS 212	4
GEOSC 105/MATH 136	4
Electives	3
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<b><u>Physics Concentration</u></b>	
PHYS 111 Physics 1 for Scientists and Engineers	4
PHYS 212 Physics 2 for Scientists and Engineers	4
PHYS 213 Physics 3 for Scientists and Engineers	4
MATH 136 Calculus of a Single Variable 2	4
MATH 205 Multivariable Calculus	4
MATH 215 Differential Equation	4
Electives	6
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2. Describe the educational objectives and intended student learning outcomes.

The major goal of all courses in the sciences is to involve students actively in the use and understanding of the scientific method, using a variety of instructional modes such as technology, analysis and interpretation of data, oral and written communication, information literacy, problem solving, and critical thinking skills. To that end, there are four program goals for the sciences division at CCC (Figure 1). Each of the course objectives in all science division courses have been aligned to either a Science Division program goal (PG) or a college General Education goal (GE), or both. The following goals are the revised goals of current similar goals and with the approval of the program, these goals will be launched in all of the courses as of Fall 2018 semester.

**Goal 1: Students will apply the process of science to questions in the laboratory and field**

Outcome 1: Generate a valid hypothesis to a question

Outcome 2: Identify appropriate variables and controls for an investigation

Outcome 3: Collect valid and repeatable data safely using appropriate techniques and/or technology

**Goal 4: Students will recognize the interdisciplinary nature of science and the relationship of science and society**

Outcome 1: Use an interdisciplinary approach to discuss scientific problems

Outcome 2: Discuss the interrelationship of science and society in addressing problems

Outcome 3: Evaluate the ethical implications of scientific research

Outcome 4: Identify the universal importance of safety

**Figure 1: Table of Science Division Program Goals and Learning Outcomes**

An AS in Physical Sciences degree with the provided concentrations in chemistry, geology and physics well prepares the students who would like to pursue further higher education towards a bachelor's degree in such fields.

3. Discuss how general education requirements will be met, if applicable.

CCC has seven General Education goals that meet the Code of Maryland Regulations (COMAR) regulations. Each course in the proposed Associate of Science in Physical Sciences degree program of study has had its course objectives mapped to these General Education goals. General Education requirements will be met in the core courses of the proposed degree program.

1) Communication (Written and Oral)

Students will communicate effectively in writing and in speech, and interpret the written and oral expressions of others.

- Assess and address a specific audience to accomplish a goal
- Craft an arguable thesis statement and support it with evidence
- Explore and respond to differing perspectives
- Use standard English in academic and professional settings

2) Critical Thinking

Students will practice analytical and evaluative thinking with a view toward continuous improvement.

- Independently identify problems and pose questions
- Gather, read, evaluate, and integrate relevant information
- Explore alternative perspectives and their implications

- Draw well-reasoned conclusions

3) Quantitative and Scientific Reasoning

Students will apply mathematical and scientific concepts and theories to identify and analyze problem-solving situation.

- Apply models and methods to define, represent, and solve mathematical and scientific problems
- Make observations, identify problems, formulate questions and hypotheses
- Collect and interpret data in order to draw valid conclusions and identify logical relationships
- Distinguish scientific arguments from non-scientific arguments

4) Information & Technology Literacy

Students will research, create, and communicate information through appropriate technology.

- Select appropriate search methods for gathering information
- Evaluate the authority, reliability, accuracy, and currency of information sources
- Demonstrate an awareness of the ethical, legal, and cultural issues and responsibilities in the uses of information and technology
- Design, develop, and produce media that effectively communicate information and ideas

5) Creativity

Students will explore and appreciate the creative processes that shape the human experience.

- Appreciate creative expression as a reflection of culture and history
- Identify how creative processes lead to discovery and innovation
- Define and analyze stylistic nuances in artistic forms
- Examine a significant work of art or great idea and its cultural influence

6) Global Awareness

Students will acknowledge and comprehend the beliefs, behaviors, and values of diverse populations within a global environment.

- Analyze and evaluate the significance of cultures and societies from a variety of perspectives
- Explain the impact of economic, political, and technological changes on diverse cultures
- Examine the interdependence of humanity
- Appreciate the commonalities and the differences among world cultures

7) Personal Development and Social Responsibility

Students will recognize and engage in personal and social behaviors responsible for the wellness of self and community.

- Develop a framework for ethical decision making and personal responsibility
- Examine how personal behaviors affect self and others
- Collaborate with others to achieve a common goal
- Participate in and reflect on personal learning experiences

4. Identify any specialized accreditation or graduate certification requirements for this program and its students.



There are no specialized accreditation or graduate certification requirements for this program. Students who complete this program would receive an AS in Physical Sciences from CCC.

5. If contracting with another institution or non-collegiate organization, provide a copy of the written contract.

At this time, there are no agreements with other educational institutions or local applicable business that are interested in providing cooperative education opportunities in the area of physical sciences.

**C. Critical and compelling regional or Statewide need as identified in the State Plan:**

1. Demonstrate demand and need for the program in terms of meeting present and future needs of the region and the State in general based on one or more of the following:
  - The need for the advancement and evolution of knowledge;
  - Societal needs, including expanding educational opportunities and choices for minority and educationally disadvantaged students at institutions of higher education;
  - The need to strengthen and expand the capacity of historically black institutions to provide high quality and unique educational programs.

The Maryland Higher Education Commission cites data from the Georgetown University Center for Education and the Workforce (2011) ranking STEM jobs as the second fastest-growing occupational category in the nation, behind health care” (Carnevale, Al, Smith, N., & Melton, M. p. 12). Further, the Maryland Higher Education Commission states that “Maryland has the second highest concentration of STEM jobs in the nation, and is adding employment opportunities in these areas faster than all but five other states” (p. 27).

2. Provide evidence that the perceived need is consistent with the Maryland State Plan for Postsecondary Education.

Through its concentrations in Chemistry, Geology, and Physics, the proposed A.S. in Physical Sciences degree program will directly address this critical need which is “closely tied to technological innovation, economic growth, and increased productivity” for the nation, state, and region (Maryland Higher Education Commission, 2014, p.12). Specifically, the goals of the State Plan will be supported as follows:

Goal 1: Quality and Effectiveness – The proposed A.S. in Physical Sciences degree program provides a clear pathway to degree completion and further study, through its concentrations designed to transition into baccalaureate degree programs at several Maryland institutions of higher education.

Goal 2: Access, Affordability, and Completion – The proposed A.S. in Physical Sciences degree program provides a direct, affordable educational contribution to national, state, and regional employment needs in the STEM fields of Chemistry, Geology, and Physics.

Goal 3: Diversity - The proposed A.S. in Physical Sciences degree program directly supports the State Plan’s goal of creating affordable, innovative, high quality undergraduate programs for all of its

citizens, through the state's community college system.

Goal 4: Innovation - The proposed A.S. in Physical Sciences degree program promotes early-career, undergraduate research experiences in Chemistry, Geology, and Physics, at the community college level, in support of the State Plan's goal of innovation in postsecondary education.

Goal 5: Economic Growth and Vitality - The proposed A.S. in Physical Sciences degree program contributes directly, through its concentrations in Chemistry, Geology, and Physics, to the goals of creating a knowledge-based economy, and promoting the advancement of research by exposing students to exploratory experiences early in their educational programs.

**D. Quantifiable & reliable evidence and documentation of market supply & demand in the region and State:**

1. Present data and analysis projecting market demand and the availability of openings in a job market to be served by the new program.

United States Bureau of Labor Statistics (Bureau of Labor Statistics, 2017) states that recent indicators show that demand for professionals holding a Physical Sciences degree will remain. The report states that the employment of life, physical, and social science occupations is projected to grow 7 percent, about as fast as the average from 2014 to 2024, which will result in about 97,600 new jobs. The median annual wage for life, physical, and social science occupations was \$63,340 in May 2016, which was higher than the median wage for all occupations of \$37,040. According to this report:

- Chemical technicians use special instruments and techniques to help chemists and chemical engineers research, develop, produce, and test chemical products and processes. An associate degree earns a median of \$45,840.
- Geological and petroleum technicians provide support to scientists and engineers in exploring and extracting natural resources, such as minerals, oil, and natural gas. An associate degree earns a median of \$56,470.
- Physicists study the ways in which various forms of matter and energy interact. Theoretical physicists may study the nature of time or the origin of the universe. Some physicists design and perform experiments with sophisticated equipment such as particle accelerators, electron microscopes, and lasers. A professional degree earns a median of \$114,870.

According to the latest directive from Maryland Governor's Workforce Investment Board (Governor's Workforce, 2009), the STEM industries face a looming retirement cliff as skilled baby boomers begin to retire and separate from the workforce. The state's aerospace industry serves as a prime example. Fifty percent of the current aerospace workforce is set to retire by 2020. The board recommends increased opportunities for young people to become aware of and enter STEM careers. These can include careers in Chemistry, Geology and Physics.

CCC takes a leading role in regional growth and opportunities for students seeking jobs in the physical sciences. Students are encouraged by providing opportunities of career advancement through job fairs and making guest lectures available from professionals in the field. Mechanisms put in place will help CCC students will receive a big boost from the AS in Physical Sciences degree

with concentrations in Chemistry, Geology and Physics.

2. Discuss and provide evidence of market surveys that clearly provide quantifiable and reliable data on the educational and training needs and the anticipated number of vacancies expected over the next 5 years.

The A.S. in Physical Sciences degree with concentrations in Chemistry, Geology and Physics can provide professional growth and increased opportunity for students interested in the STEM field, especially in the Physical Sciences (United States Bureau of Labor Statistics, 2017). According to a 2012 White House report (Feder, 2012), STEM fields will need over a million workers to keep up with demand.

United States Bureau of Labor Statistics data, summarized in figure 2 below, shows that for 2014-2024 there will be many fields to choose from for a student graduating with an A.S. in a Physical Sciences degree.

Occupation	Description of tasks	Entry-Level Education	Median Salary
Chemical Technicians	Chemical technicians use special instruments and techniques to help chemists and chemical engineers research, develop, produce, and test chemical products and processes.	Associate's degree - Chemistry	\$45,840
Agricultural and Food Science Technicians	Measure and analyze the quality of food/ agricultural products; prepare reports	Associate's degree - Chemistry	\$35,140
Environmental Science and Protection Technician	Monitor the environment; investigate causes of pollution/contamination; assist in investigating public health violations	Associate's degree - Chemistry, Geology	\$42,190
Geological and Petroleum Technicians	Geological and petroleum technicians provide support to scientists and engineers in exploring and extracting natural resources, such as minerals, oil, and natural gas.	Associate's degree - Geology	\$56,470
Nuclear Technicians	Nuclear technicians assist physicists, engineers, and other professionals in nuclear research and nuclear energy production. They operate special equipment used in these activities and monitor the levels of radiation that are produced.	Associate's degree - Physics	\$29,960
Physicists and Astronomers	Physicists and astronomers study the ways in which various forms of matter and energy interact. Theoretical physicists and astronomers may study the nature of time or the origin of the universe. Some physicists design and perform experiments with	Doctoral or professional degree supported by the ASPS	\$114,870
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sophisticated equipment such as particle accelerators, electron microscopes, and lasers.

Figure 2. Entry Level Positions Requiring an Associate's Degree

3. Data showing the current and projected supply of prospective graduates.

According to the American Chemical Society, the employment world for chemical professionals can be divided into five main sectors: industry, academia, government, non-profit, and entrepreneurship. Within the U.S. chemical manufacturing sector in particular, employment rose 1.2% to 792,600 in 2013, according to Bureau of Labor Statistics (2017). This gain was the first since 1998, when employment in the sector stood at 992,800, points out Martha Gilchrist Moore, senior director for policy analysis and economics for the American Chemistry Council (ACC), the chemical industry's main trade association. She anticipates that employment will keep rising for chemists and chemical engineers in the chemical manufacturing sector.

The American Institute of Physics estimates the physics enrollment has been growing at a pace of 3.7% since 1995-96. It also provides a state-by-state listing of employers hiring recent physics undergraduates. These include John Hopkins Center for Advanced Modeling, Maryland Environmental Sciences, National Aeronautics and Space Administration (NASA), National Institute of Standards and Technology (NIST), University of Maryland College Park just to name a few in the state of Maryland.

For Geology, American Geoscience Institutes provides data for Workforce in Maryland for all degree levels as 6,760 geoscience employees (non-federal/self-employed) in 2015 with \$80,800 as the average median geoscience employee salary. It also indicates 1,300 jobs in extractive industries in 2015 and 13 academic geoscience departments.

CCC strives to train the students to pursue careers in higher education and technology. An A.S. degree in Physical Sciences with concentrations in Chemistry, Geology and Physics will empower CCC students to establish strong educational background which will launch them on successful career pathways.

**E. Reasonableness of program duplication:**

1. Identify similar programs in the State and/or same geographical area. Discuss similarities and differences between the proposed program and others in the same degree to be awarded.

It is not anticipated that the A.S. in Physical Sciences degree with concentrations in Chemistry, Geology and Physics will draw students from similar programs in nearby geographical region (Figure 4). Rather, the degree is giving a carefully-designed curriculum to CCC students who live in Carroll County.

Name of Community College	Relevant degrees in Physical Sciences Areas	Degree Offerings by Subject in Physical Sciences and/or Related Areas
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Community College of Baltimore County	Technology, Math and Science pathway to degree	Transfer degree in Astronomy, Biology, Chemistry, Environmental Sciences, Forensic Science, Geography, Geology, Meteorology, Oceanography and Physics.
Community College of Baltimore City	Technology, Math, and Science Pathway to degree	29 associate degree programs and 16 certifications in high-demand fields.
Hagerstown Community College	AS	AS options are in Biology, Biotechnology, Chemistry, Mathematics, Physics, and Pre-Pharmacy.
Montgomery College	Standalone degrees	Transfer degrees in Biotech, Chemistry and Biochemistry, Engineering, Environmental Science, Life Sciences, Physics, and Mathematics.
Frederick Community College	AS-STEM	AS-STEM and 85 degree and certificate programs as well as workforce training and continuing education

Figure 4. Transfer degree offered by institutions in proximity to CCC

2. Provide justification for the proposed program.

CCC has been providing students with transfer recommendations with careful guidance from the office of Advising and Transfer. However, these were only guidance and some students were not following the recommendations and were taking courses without proper advising and thus taking unnecessary credits. An A.S. in Physical Sciences degree with concentrations in Chemistry, Geology and Physics will require students to take both core courses and specific programmatic courses from perspectives of both to achieve their goals and to also earn a degree benefit the students to clearly defined pathways to achieve their goals and also earn an associate degree with 60 credits in a two-year period.

**F. Relevance to Historically Black Institutions (HBIs):**

1. Discuss the program’s potential impact on the implementation or maintenance of high-demand programs at HBI’s.

The proposed A.S. in Physical Sciences degree program with concentrations in Chemistry, Geology and Physics is transferrable to all Maryland institutions of higher education including those that are designated HBIs, and so may increase the participation of students in STEM fields.

2. Discuss the program’s potential impact on the uniqueness and institutional identities and missions of HBIs.

It is not anticipated that this program will have an impact on uniqueness and institutional identities and missions of HBIs.

**G. If proposing a distance education program, please provide evidence of the Principles of Good Practice (as outlined in COMAR 13B.02.03.22C):**

This section applies to distance education and distance education programs offered by an institution of higher education operating in this State that is required to have a certificate of approval from the Commission under chapter .01 or .02 of this subtitle. An institution shall provide evidence to the Secretary of compliance with the principles of good practice in this section.

**1. Curriculum and Instruction**

- a. A distance education program shall be established and overseen by qualified faculty.

Not applicable

- b. A program's curriculum shall be coherent, cohesive, and comparable in academic rigor to programs offered in traditional instructional formats.

Not applicable

- c. A program shall result in learning outcomes appropriate to the rigor and breadth of the program.

Not applicable

- d. A program shall provide for appropriate real-time or delayed interaction between faculty and students.

Not applicable

- e. Faculty members in appropriate disciplines in collaboration with other institutional personnel shall participate in the design of courses offered through a distance education program.

Not applicable

**2. Role and Mission**

- a. A distance education program shall be consistent with the institution's mission.

Not applicable

- b. Review and approval processes shall ensure the appropriateness of the technology being used to meet a program's objectives.

Not applicable

3. Faculty Support

- a. An institution shall provide for training for faculty who teach with the use of technology in a distance education format, including training in the learning management system and the pedagogy of distance education.

Not applicable

- b. Principles of best practice for teaching in a distance education format shall be developed and maintained by the faculty.

Not applicable

- c. An institution shall provide faculty support services specifically related to teaching through a distance education format.

Not applicable

4. An institution shall ensure that appropriate learning resources are available to students including appropriate and adequate library services and resources.

Not applicable

5. Students and Student Services

- a. A distance education program shall provide students with clear, complete, and timely information on the curriculum, course and degree requirements, nature of faculty/student interaction, assumptions about technology competence and skills, technical equipment requirements, learning management system, availability of academic support services and financial aid resources, and costs and payment policies.

Not applicable

- b. Enrolled students shall have reasonable and adequate access to the range of student services to support their distance education activities.

Not applicable

- c. Accepted students shall have the background, knowledge, and technical skills needed to undertake a distance education program.

Not applicable

- d. Advertising, recruiting, and admissions materials shall clearly and accurately represent the program and the services available.

Not applicable

6. Commitment to Support

- a. Policies for faculty evaluation shall include appropriate consideration of teaching and scholarly activities related to distance education programs.

Not applicable

- b. An institution shall demonstrate a commitment to ongoing support, both financial and technical, and to continuation of a program for a period sufficient to enable students to complete a degree or certificate.

Not applicable

7. Evaluation and Assessment

- a. An institution shall evaluate a distance education program's educational effectiveness, including assessments of student learning outcomes, student retention, student and faculty satisfaction, and cost-effectiveness.

Not applicable

- b. An institution shall demonstrate an evidence-based approach to best online teaching practices.

Not applicable

- c. An institution shall provide for assessment and documentation of student achievement of learning outcomes in a distance education program.

Not applicable

**H. Adequacy of faculty resources (as outlined in COMAR 13B.02.03.11):**

- 1. Provide a brief narrative demonstrating the quality of program faculty. Include a summary list of faculty with appointment type, terminal degree title and field, academic title/rank, status (full-time, part-time, adjunct) and the course(s) each faculty member will teach.

Faculty members in Science and Mathematics Divisions all have significant professional and instructional experience. Full-time faculty members provide curricular leadership and program management functions. They collaborate with advising teams at CCC to advise students who have shown an interest in pursuing higher education in chemistry, geology and in physics. Figure 5 lists faculty teaching in the A.S. in Physical Sciences program with concentrations in Chemistry, Geology and Physics.

Faculty Name	Highest Degree	Rank	Discipline	Status	Courses Taught
Jamshed	Ph.D.	Assistant	Chemistry	FT	CHEM-101
Ayub	Biomedical	Professor			CHEM-105



	Sciences				CHEM-106
Elizabeth Bush	M.S. Mathematics	Assistant Professor	Mathematics	FT	MATH-135
Tricia Crossett	M.A. Education – Sec. Math	Assistant Professor	Mathematics	FT	MATH-136
Joe Harris	M.Ed. Science Ed.	Adjunct	Chemistry	PT	MATH-135
Bill Kelvey	M.S. Geography	Associate Professor	Geology	FT	CHEM-105
Raza Khan	Ph.D. Chemistry	Associate Professor	Chemistry	FT	CHEM-106
Sithy Maharroof	Ph.D. Physics	Assistant Professor	Physics	FT	GEOSC-103
Michael O’Neal	Ph.D. Geology & Geophysics	Associate Professor	Geology	FT	GEOSC-105
James Sherman	M.S. Electrical Engineering	Assistant Professor	Mathematics	FT	CHEM-201
Bryan Shumaker	B.S. Physics	Adjunct	Physics	PT	CHEM-202
Janice Stencil	M.S. Mathematics	Assistant Professor	Mathematics	FT	PHYS-101, 102, 111 & 212
Tom Shields	M.S. Physics	Assistant Professor	Mathematics	FT	GEOSC-110, 121 & 123
					MATH-135
					MATH-136
					PHYS-213
					MATH-135, MATH-136, 205 & 215
					MATH-135, 136, 205 & 215

Figure 5. Teaching Faculty in the AS in Physical Sciences program

**I. Adequacy of library resources (as outlined in COMAR 13B.02.03.12):**

1. Describe the library resources available and/or the measures to be taken to ensure resources are adequate to support the proposed program. **If the program is to be implemented within existing institutional resources**, include a supportive statement by the President for library resources to meet the program’s needs.

Currently, the library has sufficient resources to offer an AS in Physical Sciences degree with concentrations in Chemistry, Geology and Physics. Students and faculty have access to interlibrary loans and electronic journals. As of to-date, the library exceeds state and national standards for community colleges’ learning resource programs. One of the librarians is also designated as a liaison for the Sciences Division who is frequently contacted for bibliographical searches and for the purchase of discipline-specific materials.

With the approval of the A.S. in Physical Sciences, the Science Division would like to ensure that at

least 1-2 professional journals are subscribed to in the area of Chemistry, Geology and Physics concentrations for capstone projects. It needs to be noted that such a purchase would exceed the requirements of library holdings to offer the degree program.

**J. Adequacy of physical facilities, infrastructure and instructional equipment (as outlined in COMAR 13B.02.03.13):**

1. Provide an assurance that physical facilities, infrastructure and instruction equipment are adequate to initiate the program, particularly as related to spaces for classrooms, staff and faculty offices, and laboratories for studies in the technologies and sciences. If the program is to be implemented within existing institutional resources, include a supportive statement by the President for adequate equipment and facilities to meet the program's needs.

Current physical facilities and infrastructure at Carroll Community College are adequate to offer the new degree program without the need for additional resources.

Classrooms are equipped with the latest and updated instructional equipment which includes: computers, audio and visual devices which includes projectors. Carroll's Information Technology department supports this equipment with software updates and any maintenance or repairs necessary to maintain quality instruction.

Recent conversions of classrooms into laboratory rooms have been made. Currently, the laboratories in the C, K, M, and A buildings support all the science courses that have a lab component.

Computers are available for student, faculty and staff use in classrooms, computer labs, and the library. Free printing and wireless internet access can be found in all those locations.

The Testing Center is available to instructors for students with disability accommodation needs.

The advising staff provides course information that will assist students interested in pursuing study of biology.

The College complies with the American with Disabilities Act and has the necessary infrastructure and instructional equipment for ADA accommodations. The Office of Student Support Services provides the evaluations for ADA accommodations.

**K. Adequacy of financial resources with documentation (as outlined in COMAR 13B.02.03.14):**

1. Complete Table 1: Resources and Table 2: Expenditures. Finance data for the first five years of program implementation are to be entered. Figures should be presented for five years and then totaled by category for each year.
2. Provide a narrative rationale for each of the resource categories. If resources have been or will be reallocated to support the proposed program, briefly discuss the sources of those funds.

<b>TABLE 1: RESOURCES</b>					
Resource Categories	Year 1	Year 2	Year 3	Year 4	Year 5
	2018-19	2019-20	2020-21	2021-22	2022-23
1. Reallocated Funds	-	-	-	-	-
2. Tuition/Fee Revenue (c + g below)	\$29,315	\$38,248	\$52,875	\$58,710	\$69,246
a. Number of F/T Students	5	7	9	10	12
b. Annual Tuition/Fee Rate	\$3,907	\$4,024	\$4,145	\$4,269	\$4,398
c. Total F/T Revenue (a x b)	\$19,535	\$28,168	\$37,305	\$42,690	\$52,776
d. Number of P/T Students	4	4	6	6	6
e. Credit Hour Rate	\$163	\$168	\$173	\$178	\$183
f. Annual Credit Hour Rate	15	15	15	15	15
g. Total P/T Revenue (d x e x f)	\$9,780	\$10,080	\$15,570	\$16,020	\$16,470
3. Grants, Contracts & Other External Sources	-	-	-	-	-
4. Other Sources	-	-	-	-	-
<b>TOTAL (Add 1 – 4)</b>	<b>\$29,315</b>	<b>\$38,248</b>	<b>\$52,875</b>	<b>\$58,710</b>	<b>\$69,246</b>

Narrative for Table 1: Resources

1. Reallocated Funds: Carroll Community College does not anticipate any need to reallocate funds from any other area to support this program.
2. Tuition and Fee Revenue: The cost of both full-time and per-credit tuition is subject to a 3% increase each year.
3. Grants and Contracts: Not applicable.
4. Other Sources: Tuition will be the only resource to support this program.

TABLE 2: EXPENDITURES					
Expenditure Categories	Year 1	Year 2	Year 3	Year 4	Year 5
	2018-19	2019-20	2020-21	2021-22	2022-23
1. Faculty (b + c below)	-	-	-	-	-
a. # FTE	-	-	-	-	-
b. Total Salary	-	-	-	-	-
c. Total Benefits	-	-	-	-	-
2. Admin. Staff (b + c below)	-	-	-	-	-
a. # FTE	-	-	-	-	-
b. Total Salary	-	-	-	-	-
c. Total Benefits	-	-	-	-	-
3. Support Staff (b + c below)	-	-	-	-	-
a. # FTE	-	-	-	-	-
b. Total Salary	-	-	-	-	-
c. Total Benefits	-	-	-	-	-
4. Equipment	-	-	-	-	-
5. Library	\$1,000	\$1,000	\$1,000	\$1,000	\$1,000
6. New or Renovated Space	-	-	-	-	-
7. Other Expenses	\$2,000	\$2,000	\$1,000	\$1,000	\$1,000
<b>TOTAL (Add 1 – 7)</b>	<b>\$3,000</b>	<b>\$3,000</b>	<b>\$2,000</b>	<b>\$2,000</b>	<b>\$2,000</b>

Narrative for Table 2: Expenditures

1. Faculty (#FTE, Salary, and Benefits):

Carroll Community College already has the faculty on staff in Chemistry, Geology, and Physics to support the program.

2. Administrative Staff:

No additional administrative staff is expected in the first 5 years of the program.

3. Support Staff:

No additional support staff is expected in the first 5 years of the program.

4. Equipment:

No additional equipment is expected in the first 5 years of the program.

5. Library:

The current library loan mechanism and the electronic retrieval methods will be used for the Physical Science program. Even though it is not anticipated that any new library holdings will be required, for the betterment of students who wish to become members of professional organizations or go beyond the required expectations in their capstone projects, the Division will request that the library invest in subscriptions to one or two professional journals.

6. New or Renovated Space:

No new or renovated space needs are expected in the first 5 years of the program

7. Other Expenses:

Marketing and faculty development expenses are expected in the first five years of the program.

**L. Adequacy of provisions for evaluation of program (as outlined in COMAR 13B.02.03.15):**

Discuss procedures for evaluating courses, faculty and student learning outcomes.

The Sciences Division has established courses that are in alignment with the college's mission and general education goals. To that end, the Division undergoes evaluation of courses, curriculum, and faculty on an annual basis. Faculty reflect both on curricular changes, professional development activities and also future goals related to student learning via an annual self-evaluation report which is accompanied by the supervisory evaluation report. The self-report includes reflection on student evaluations that are returned to the faculty after the end of each semester. Student feedback is of particular interest to both faculty and the Chair of the Division. With the approval of the proposed program of A.S. in Physical Sciences, the Division will capture feedback from alumni of the program as they move to either the workforce or pursue higher education at a four-year institutions upon transfer and/or graduation. Sciences faculty are also very active both in external professional development opportunities such as making presentations and/or attending local, regional and national conferences. They also seek out internal financial support such as the Summer Stipend to Improve Student Learning (SSISL) grant at the College that promotes curriculum development and updates to enhance learning.

The Sciences Division has four program goals. The Division faculty met together and revised the four goals (mentioned earlier) which will be both launched in 2018 Fall semester and are in line with the proposed program of A.S. in Physical Sciences with concentrations in Chemistry, Geology and Physics.

The Division conducts and documents an Annual Assessment Report of select objectives that are chosen at random on yearly basis. In addition, a comprehensive Program Review is conducted every five years. The purpose of the review is to evaluate the effectiveness of the academic programs through the evaluation of curriculum, faculty, student enrollment and retention, and student learning outcomes. The review process ensures that the following are reflected in the document:

- 1) The mission of the college and how the needs of the community are met.
- 2) Student performance sustainment at a high level
- 3) Transferability and/or workforce applicability

- 4) Curriculum strengths and weakness
- 5) Resources are adequate to support its efforts.

**M. Consistency with the State's minority student achievement goals (as outlined in COMAR 13B.02.03.05 and in the State Plan for Postsecondary Education):**

Discuss how the proposed program addresses minority student access & success, and the institution's cultural diversity goals and initiatives.

CCC has long been committed to the recruitment and retention of minority students and will expand its services and policies to include this program. Data on minority enrollment in the A.S. in Physical Sciences degree will be monitored by the Sciences Division Chair to determine how underrepresented minorities can be recruited and retained. CCC currently provides academic tutorial support and a retention alert system to identify academic related issues students are experiencing. A College-wide Diversity Committee identifies and promotes service learning projects that are tied into academics and diversity awareness among the campus community.

**N. Relationship to low productivity programs identified by the Commission:**

If the proposed program is directly related to an identified low productivity program, discuss how the fiscal resources (including faculty, administration, library resources and general operating expenses) may be redistributed to this program.

Currently there are no low-productivity programs at the College which can be redirected.

## REFERENCES

- Carnevale, Al, Smith, N., & Melton, M. (2011) *STEM*. Georgetown University Center on Education and the Workforce. Retrieved from <http://cew.georgetown.edu/STEM/>.
- Feder, M. (2012). *One decade, one million more STEM graduates*. Retrieved from <https://obamawhitehouse.archives.gov/blog/2012/12/18/one-decade-one-million-more-stem-graduates>.
- Maryland Department of Labor, Licensing, and Regulation. Governor's Workforce Development Board. (2009). *Maryland's labor force conditions: Trends, challenges & opportunities*. Retrieved from: <http://www.gwdb.maryland.gov/lib/pdf/laborforceconsum.pdf>
- Maryland Higher Education Commission. (2014). *Maryland ready: 2013-2017 Maryland state plan for postsecondary education*. Retrieved from [http://mhec.maryland.gov/Documents/MHECStatePlan\\_2014.pdf](http://mhec.maryland.gov/Documents/MHECStatePlan_2014.pdf).
- U.S. Department of Labor, Bureau of Labor Statistics. (2017, October 24). Life, physical, and social science occupations. In *Occupational Outlook Handbook* (2016-17 ed.). Retrieved from <https://www.bls.gov/ooh/life-physical-and-social-science/home.htm>.

## APPENDICES



## Appendix A

### Physical Sciences A.S. Course Descriptions

#### Core Courses Descriptions

**CHEM-105, General Chemistry 1**, is the first semester course for students who intend to major in chemistry, life sciences and other areas that require a minimum of one semester and/or one year of college chemistry. Topics covered in the course include study of matter and measurements, atoms, molecules and ions, stoichiometry involving chemical reactions, solution stoichiometry, thermochemistry, and the electronic structure of the atom, periodic properties, chemical bonding, molecular geometry, and the physical behavior of gases. Prerequisite: exemption/completion with a C grade or better in CHEM-101 (or READ A-F and high school chemistry with advisor signature) and MATH-123. Three hours lecture and three hours laboratory each week. Four credits. Four billable hours. GENERAL EDUCATION

**CHEM-106, General Chemistry 2**, is a continuation of CHEM 105 for students who intend to major in chemistry, life sciences and other areas that require a minimum of one semester and/or one year of college chemistry. Topics covered in the course include the study of intermolecular forces in liquids and solids, phase changes, properties of solutions, chemical kinetics, gaseous and aqueous equilibria, acids and bases, chemical thermodynamics, electrochemistry, and introduction to nuclear, organic and biological chemistry. Prerequisite: CHEM-105 and MATH-123 with C grades or better. Three hours lecture and three hours laboratory each week. Four credits. Four billable hours. GENERAL EDUCATION

**ENGL-101, College Writing**, develops critical reading, thinking, and writing skills. Students will use the writing process to compose academic essays that support a thesis statement, use Standard English, including proper punctuation and sentence structure, and conduct and document academic research, culminating in at least one researched-based essay. Students will compile Part 1 of a writing portfolio that will be evaluated as the final examination. In addition, students will spend an hour per week outside of the classroom engaged in Expression Workshop activities, which include student-teacher conferences, writing seminars, and online instruction in sentence-level skills. Prerequisite: ENG A-E or a score of 90 or higher on the placement test, and concurrent enrollment in, successful completion of, or exemption from READ A-F. Four hours lecture each week. Three credits. Four billable hours. GENERAL EDUCATION

**ENGL-102, Writing About Literature**, provides a program in critical reading and interpretive writing. Students will build on rhetorical and research skills developed in English 101 by critically reading literature from three genres, writing analytical and interpretative essays, and conducting and documenting academic research, culminating in at least one research essay. Students will also study the principles of three literary types (fiction, poetry, and drama) by reading and analyzing examples of each. Throughout the course, students will compile Part 2 of their writing portfolios, which will be evaluated as the final examination. Prerequisite: ENGL-101. Three hours lecture each week. Three credits. Three billable hours. DIVERSITY/WORLD GENERAL EDUCATION

**MATH-135, Calculus of a Single Variable 1**, Calculus of a Single Variable 1 introduces the initial concepts of both differential and integral calculus. The concept of limits will be introduced both informally and through the formal epsilon- delta process. Derivatives and integrals of polynomial, power, and trigonometric functions will be developed as well as general differentiation techniques (such as the

chain rule and implicit differentiation). Evaluation of definite integrals will be covered through limits of Riemann Sums, numerical integration techniques, and the Fundamental Theorems of Calculus. Applications of calculus to graphing and to physical situations will be extensively developed. Prerequisite: exemption/completion of READ A-F, plus MATH-123/MATH-124 or MATH-130 with a C grade or better, or satisfactory scores on the placement exam. Credit by exam available. Five hours lecture each week. Four credits. Four billable hours. GENERAL EDUCATION

#### Chemistry Concentration Course Descriptions:

**BIOL-101, Fundamentals of Biology 1**, gives the student who is a science major the basic biological principles common to all living things. Biochemistry, genetics, and evolution serve as central themes for the topics, which include cell structure and function, molecular and cellular energetics, and genetics. Through experiments the student will gain familiarity with various biological techniques and principles. The course includes formulating questions and hypotheses, designing experiments and the collection, reporting, and interpretation of data. Prerequisite: exemption/completion of READ A-F and MAT-097 with a C grade or better. Credit by exam available. Three hours lecture, three hours laboratory each week. GENERAL EDUCATION

**CHEM-201, Organic Chemistry 1**, is the first semester course in college level organic chemistry. This course fulfills the requirements for students who are chemistry majors, life science majors or pursuing other majors that require college level organic chemistry. Topics covered in the course include foundational aspects of hydrocarbons and their select derivatives including functional groups on their structure, stereochemistry, reactions, and acid-base chemistry. Prerequisite: CHEM-106 with a grade of C or better. Three hours lecture and four hours laboratory each week. Five credits. Five billable hours. Offered fall term only.

**CHEM-202, Organic Chemistry 2**, is the second semester course in college level organic chemistry. This course fulfills the requirements for students who are chemistry majors, life science majors or pursuing a major that requires a two semester sequence of college level organic chemistry. Topics covered in the course include nomenclature, structural determination and mechanisms of reactions of functional groups including biomolecules. Prerequisite: CHEM-201 with a grade of C or better. Three hours lecture and four hours laboratory. Five credits. Five billable hours. Offered spring term only.

**MATH -136: Calculus of a Single Variable 2**, expands the group of functions whose derivatives and integrals are studied in MATH-135. Functions added are the exponential, logarithmic, inverse trigonometric and hyperbolic functions. Infinite sequences and series, including convergence tests, power series and Taylor and Maclaurin series, are studied. An introduction is given for conic sections, and derivatives and integrals in parametric and polar coordinates are covered. Students will be required to use mathematical software such as Mathematica, Maple, or MATLAB throughout the course. Prerequisite: MATH-135 with a C grade or better. Five hours lecture each week. Four credits. Four billable hours.

**PHYS-101, Fundamentals of Physics 1**, is a first-semester course in the basic principles of physics for students who do not intend to major in either engineering or the physical sciences. It is an introduction to the phenomena, concepts, and theories of classical and modern physics, including: Newtonian mechanics, kinematics, dynamics, momentum, energy, and heat energy. The course demands a

mathematical knowledge of algebra and trigonometry. Prerequisite: exemption/completion of READ A-F and MATH-123 or MATH-128 with a C grade or better. Students will not receive credit for both PHYS-101 and PHYS-111. Three hours lecture, three hours laboratory each week. Four credits. Four billable hours.

GENERAL EDUCATION

**PHYS-102, Fundamentals of Physics 2**, is a second-semester course in the basic principles of physics for students who do not intend to major in either engineering or the physical sciences. It is an introduction to the phenomena, concepts, and theories of classical and modern physics, including the following topics: electricity, magnetism, E-M waves, geometric and wave optics, relativity, and selected topics from atomic physics. The course demands a mathematical knowledge of algebra and trigonometry.

Prerequisite: exemption/completion of READ A-F and PHYS-101 with a grade of C or better. Students will not receive credit for both PHYS-102 and PHYS-212. Credit by exam available. Three hours lecture, three hours laboratory each week. Four credits. Four billable hours. GENERAL EDUCATION

**PHYS-111, Physics 1 for Scientists and Engineers**, is the first semester of a three-semester calculus-based physics course intended for physics, physical science, engineering and related science majors. The course will enable the student to solve problems for the major concepts in mechanics and particle dynamics including: measurement, vector concepts, kinematics, dynamics, statics, gravitation, energy, momentum, rotation dynamics, and fluids. The student will interpret and apply the experimental laws and fundamental principles of physics to describe the behavior of the physical world. In the laboratory program, the student will develop the ability to collect, appraise, use, and interpret data in order to express mathematically or explain the physical phenomena observed. Credit will not be given for both PHYS-101 and PHYS-111. Prerequisite: MATH-135 with a grade of C or better and concurrent enrollment in MATH-136. Three hours lecture, three hours laboratory each week. Four credits. Four billable hours.

GENERAL EDUCATION

**PHYS-212, Physics 2 for Scientists and Engineers**, is the second semester of a three-semester calculus-based physics course. The course will enable the student to solve problems, using calculus methods when applicable, for the major concepts in physics to include: kinetic theory, heat and thermodynamics, electrostatics, electricity through the fundamentals of DC and AC circuits, magnetic and induction, and EM waves. The student will interpret and apply the experimental laws and fundamental principles of physics to describe the behavior of the physical world. In the laboratory, the student will develop the ability to collect, appraise, use, and interpret data in order to express mathematically and/or explain the physical phenomena observed. Prerequisite: PHYS-111 and MATH-136, both with C grades or higher.

Three hours lecture and three hours laboratory each week. Four credits. Four billable hours. GENERAL EDUCATION

#### Geology Concentration Course Descriptions:

**GEOSC-103, Environmental Sustainability**, will study the interaction between humans, and the natural environment. Earth systems, such as biogeochemical cycles and climate dynamics, will be explored along with human population growth and development, energy usage, and the human impact on earth systems. Topics to be considered: Human society and consumption, energy basics, nonrenewable energy sources, nuclear energy, renewable energy sources, world pollution issues, electricity production, anthropogenic climate change, food and water security, sustainability and conservation. This course is intended to meet general education science requirement for non-science majors. Prerequisite: exemption/completion of MAT-097 with a C grade or better and READ A-F. Three hours lecture each

week. Three credits. Three billable hours. GENERAL EDUCATION

**GEOSC-105, Introduction to Oceanography**, explores the world ocean that covers more than 70% of the earth's surface. It looks at the biology, geology, chemistry and other physical properties of the sea. We will explore global effects of the world ocean as well as tiny oases, the deep ocean floor, to the shallows of the coastal areas. Oceanography Laboratory is a series of exercises designed to give the student experience in working with oceanographic data and techniques. Topics include determination of chemical and physical properties of sea water, investigations of biological communities, and examination of coastal and shoreline features. Prerequisites: exemption/completion of MAT-097 with a grade of C or better and READ A-F. Three hours lecture and two hours lab each week. Four credits. Four billable hours. GENERAL EDUCATION

**GEOSC-110, Physical Geography**, involves the study and spatial analysis of conditions on the earth's surface, including the atmosphere, hydrosphere, lithosphere, and biosphere. It will include discussion of such topics as groundwater, surface water, soils, vegetation, earthquakes, volcanoes, glaciers, weather conditions, and climate. Lab activities may include studying and calculating sun angle, relative humidity, reading and interpreting topographic maps and weather maps, using aerial photographs and satellite imagery, and analyzing earthquake and weather data from web sites. Field trips may be offered, but not required. Prerequisite: exemption/completion of MAT-097 with a grade of C or better and READ A-F. Three hours lecture, two hours laboratory each week. Four credits. Four billable hours. GENERAL EDUCATION

**GEOSC-121, Physical Geology**, introduces students to the dynamic processes and events that have shaped and continue to modify the surface and interior of planet earth, and serves as the foundation for further study in the geosciences. Inquiry-based investigations of minerals, rocks, volcanism, seismic activity, crustal deformation, and surficial modification mechanisms will be used to foster understanding of earth's surface features in plate tectonic and climatic settings. Attention will be given to the relevance of geology to society and the environment, through classroom discussions, laboratory and field exercises, projects, and presentations. Suitable for major and non-science major students. Field trips may be required. Prerequisites: exemption/completion of MAT-097 with a grade of C or better and READ A-F. Four credits. Four billable hours. GENERAL EDUCATION

**GEOSC-123, Historical Geology**, is a field-based research course intended to guide students in a firsthand exploration of the tectonic assembly of eastern North America during the last 1.5 billion years (Ga), through stratigraphic and structural evidence in the rock record of Maryland. Inquiry based field excursions, laboratory-based exercises, online and site-based exploration presentations, and independent field projects in the local region emphasize the factors which influenced the development and continued modification of life, climate, landforms, and their resultant environments, throughout geologic time. Outdoor walking field trips required. Prerequisites: exemption/completion of MAT-097 with a grade of C or better and READ A-F. Three hours lecture and two hours lab each week. Four credits. Four Billable hours. Audit enrollments are not permitted. GENERAL EDUCATION

**MATH-136, Calculus of a Single Variable 2**, expands the group of functions whose derivatives and integrals are studied in MATH-135. Functions added are the exponential, logarithmic, inverse trigonometric and hyperbolic functions. Infinite sequences and series, including convergence tests, power series and Taylor and Maclaurin series, are studied. An introduction is given for conic sections, and derivatives and integrals in parametric and polar coordinates are covered. Students will be required to use a graphing calculator and significant mathematical software such as Mathematica, Maple, or

MATLAB throughout the course. Prerequisite: MATH-135 with a C grade or better. Five hours lecture each week. Four credits. Four billable hours.

**PHYS-101, Fundamentals of Physics 1**, is a first-semester course in the basic principles of physics for students who do not intend to major in either engineering or the physical sciences. It is an introduction to the phenomena, concepts, and theories of classical and modern physics, including: Newtonian mechanics, kinematics, dynamics, momentum, energy, and heat energy. The course demands a mathematical knowledge of algebra and trigonometry. Prerequisite: exemption/completion of READ A-F and MATH-123 or MATH-128 with a C grade or better. Students will not receive credit for both PHYS-101 and PHYS-111. Three hours lecture, three hours laboratory each week. Four credits. Four billable hours. GENERAL EDUCATION

**PHYS-102, Fundamentals of Physics 2**, is a second-semester course in the basic principles of physics for students who do not intend to major in either engineering or the physical sciences. It is an introduction to the phenomena, concepts, and theories of classical and modern physics, including the following topics: electricity, magnetism, E-M waves, geometric and wave optics, relativity, and selected topics from atomic physics. The course demands a mathematical knowledge of algebra and trigonometry. Prerequisite: exemption/completion of READ A-F and PHYS-101 with a grade of C or better. Students will not receive credit for both PHYS-102 and PHYS-212. Credit by exam available. Three hours lecture, three hours laboratory each week. Four credits. Four billable hours. GENERAL EDUCATION

**PHYS-111, Physics 1 for Scientists and Engineers**, is the first semester of a three-semester calculus-based physics course intended for physics, physical science, engineering and related science majors. The course will enable the student to solve problems for the major concepts in mechanics and particle dynamics including: measurement, vector concepts, kinematics, dynamics, statics, gravitation, energy, momentum, rotation dynamics, and fluids. The student will interpret and apply the experimental laws and fundamental principles of physics to describe the behavior of the physical world. In the laboratory program, the student will develop the ability to collect, appraise, use, and interpret data in order to express mathematically or explain the physical phenomena observed. Credit will not be given for both PHYS-101 and PHYS-111. Prerequisite: MATH-135 with a grade of C or better and concurrent enrollment in MATH-136. Three hours lecture, three hours laboratory each week. Four credits. Four billable hours. GENERAL EDUCATION

**PHYS-212, Physics 2 for Scientists and Engineers**, is the second semester of a three-semester calculus-based physics course. The course will enable the student to solve problems, using calculus methods when applicable, for the major concepts in physics to include: kinetic theory, heat and thermodynamics, electrostatics, electricity through the fundamentals of DC and AC circuits, magnetic and induction, and EM waves. The student will interpret and apply the experimental laws and fundamental principles of physics to describe the behavior of the physical world. In the laboratory, the student will develop the ability to collect, appraise, use, and interpret data in order to express mathematically and/or explain the physical phenomena observed. Prerequisite: PHYS-111 and MATH-136, both with C grades or higher. Three hours lecture and three hours laboratory each week. Four credits. Four billable hours. GENERAL EDUCATION

### Physics Concentration Course Descriptions:

**MATH-136, Calculus of a Single Variable 2**, expands the group of functions whose derivatives and integrals are studied in MATH-135. Functions added are the exponential, logarithmic, inverse trigonometric and hyperbolic functions. Infinite sequences and series, including convergence tests, power series and Taylor and Maclaurin series, are studied. An introduction is given for conic sections, and derivatives and integrals in parametric and polar coordinates are covered. Students will be required to use a graphing calculator and significant mathematical software such as Mathematica, Maple, or MATLAB throughout the course. Prerequisite: MATH-135 with a C grade or better. Five hours lecture each week. Four credits. Four billable hours.

**MATH-205, Multivariable Calculus**, continues MATH-136 with vectors and analytic geometry in three dimensions, partial derivatives, multiple integrals, line and surface integrals, and vector field theory. Students will be required to use a graphing calculator and significant mathematical software such as Mathematica, Maple, or MATLAB throughout the course. Prerequisite: MATH-136 with a C grade or better. Five hours lecture each week. Four credits. Four billable hours.

**MATH-215, Differential Equations**, includes exact solutions of common types of first-order ordinary differential equations, exact solutions of second-order equations whose coefficients are constant, power series solutions, numerical and graphical techniques, Laplace transform methods, and linear systems. Additional topics may include applications to geometry and mechanics, matrix methods, special functions, and non-linear systems. Students will be required to use a graphing calculator and significant mathematical software such as Mathematica, Maple, or MATLAB throughout the course. Prerequisites: MATH-136 with a C grade or better. Five hours lecture each week. Four credits. Four billable hours.

**PHYS-111, Physics 1 for Scientists and Engineers**, is the first semester of a three-semester calculus-based physics course intended for physics, physical science, engineering and related science majors. The course will enable the student to solve problems for the major concepts in mechanics and particle dynamics including: measurement, vector concepts, kinematics, dynamics, statics, gravitation, energy, momentum, rotation dynamics, and fluids. The student will interpret and apply the experimental laws and fundamental principles of physics to describe the behavior of the physical world. In the laboratory program, the student will develop the ability to collect, appraise, use, and interpret data in order to express mathematically or explain the physical phenomena observed. Credit will not be given for both PHYS-101 and PHYS-111. Prerequisite: MATH-135 with a grade of C or better and concurrent enrollment in MATH-136. Three hours lecture, three hours laboratory each week. Four credits. Four billable hours.  
GENERAL EDUCATION

**PHYS-212, Physics 2 for Scientists and Engineers**, is the second semester of a three-semester calculus-based physics course. The course will enable the student to solve problems, using calculus methods when applicable, for the major concepts in physics to include: kinetic theory, heat and thermodynamics, electrostatics, electricity through the fundamentals of DC and AC circuits, magnetic and induction, and EM waves. The student will interpret and apply the experimental laws and fundamental principles of physics to describe the behavior of the physical world. In the laboratory, the student will develop the ability to collect, appraise, use, and interpret data in order to express mathematically and/or explain the physical phenomena observed. Prerequisite: PHYS-111 and MATH-136, both with C grades or higher. Three hours lecture and three hours laboratory each week. Four credits. Four billable hours. GENERAL EDUCATION

**PHYS-213, Physics 3 for Scientists and Engineers**, is the third semester of three-semester of calculus-based physics courses. The course will enable the student to solve problems, using calculus methods when applicable, for the major concepts in physics to include: waves and wave mechanics, electromagnetic waves, physical and geometric optics, relativity, atomic and molecular structure, nuclear physics and radioactivity, and introduction to quantum mechanics. The student will interpret and apply the experimental laws and fundamental principles of physics to describe the behavior of the physical world. In the laboratory, the student will develop the ability to collect, appraise, use, and interpret data in order to express mathematically and/or explain the physical phenomena observed. Prerequisite: PHYS-212 and MATH-136, both with C grades or higher and concurrent enrollment in MATH-205. Three hours lecture, three hours laboratory each week. Four credits. Four billable hours.

Appendix B

Physical Science A.S.  
General Education Assessment Tables

Academic Discipline: English	ENGL-101	ENGL-102
<b>1. Communication (Written and Oral)</b> Students will communicate effectively in writing and in speech, and interpret the written and oral expressions of others.	X	X
<b>2. Critical Thinking</b> Students will practice analytical and evaluative thinking with a view toward continuous improvement.	X	X
<b>3. Quantitative and Scientific Reasoning</b> Students will apply mathematical and scientific concepts and theories to identify and analyze problem-solving situation.		
<b>4. Information &amp; Technology Literacy</b> Students will research, create, and communicate information through appropriate technology	X	X
<b>5. Creativity</b> Students will explore and appreciate the creative process that shape the human experience.		X
<b>6. Global Awareness</b> Students will acknowledge and comprehend the beliefs, behaviors, and values of diverse populations within a global environment.	X	X
<b>7. Personal Development and Social Responsibility</b> Students will recognize and engage in personal and social behaviors responsible for the wellness of self and community.	X	X



<b>Academic Discipline: Fine &amp; Performing Arts</b>	ART-125	ART-135	FPA-101	FPA-105	MUSIC-101	MUSIC-102	MUSIC-103	MUSIC-105	THTR-101	THTR-137	SPCH-101
<b>1. Communication (Written and Oral)</b> Students will communicate effectively in writing and in speech, and interpret the written and oral expressions of others.	X	X	X	X	X	X	X	X	X	X	X
<b>2. Critical Thinking</b> Students will practice analytical and evaluative thinking with a view toward continuous improvement.											
<b>3. Quantitative and Scientific Reasoning</b> Students will apply mathematical and scientific concepts and theories to identify and analyze problem-solving situation.								X		X	
<b>4. Information &amp; Technology Literacy</b> Students will research, create, and communicate information through appropriate technology.	X	X	X	X	X	X	X	X	X	X	X
<b>5. Creativity</b> Students will explore and appreciate the creative processes that shape the human experience.	X	X	X	X	X	X	X	X	X	X	X
<b>6. Global Awareness</b> Students will acknowledge and comprehend the beliefs, behaviors, and values of diverse populations within a global environment.	X	X	X	X	X	X	X	X	X	X	X
<b>7. Personal Development and Social Responsibility</b> Students will recognize and engage in personal and social behaviors responsible for the wellness of self and community.	X	X	X	X	X	X	X	X	X	X	X

Academic Discipline: Humanities								
<b>1. Communication (Written and Oral)</b> Students will communicate effectively in writing and in speech, and interpret the written and oral expressions of others.	X	X	X	X	X	X	X	X
<b>2. Critical Thinking</b> Students will practice analytical and evaluative thinking with a view toward continuous improvement.	X	X	X	X	X	X	X	X
<b>3. Quantitative and Scientific Reasoning</b> Students will apply mathematical and scientific concepts and theories to identify and analyze problem-solving situation.								
<b>4. Information &amp; Technology Literacy</b> Students will research, create, and communicate information through appropriate technology.		X	X	X	X			

Academic Discipline: Mathematics	MATH-135	MATH-136
<b>1. Communication (Written and Oral)</b> Students will communicate effectively in writing and in speech, and interpret the written and oral expressions of others.	X	X
<b>2. Critical Thinking</b> Students will practice analytical and evaluative thinking with a view toward continuous improvement.	X	X
<b>3. Quantitative and Scientific Reasoning</b> Students will apply mathematical and scientific concepts and theories to identify and analyze problem-solving situation.	X	X
<b>4. Information &amp; Technology Literacy</b> Students will research, create, and communicate information through appropriate technology.		X
<b>5. Creativity</b> Students will explore and appreciate the creative processes that shape the human experience.		
<b>6. Global Awareness</b> Students will acknowledge and comprehend the beliefs, behaviors, and values of diverse populations within a global environment.		
<b>7. Personal Development and Social Responsibility</b> Students will recognize and engage in personal and social behaviors responsible for the wellness of self and community.		

Academic Discipline: Science (Chemistry 105 and 106 only)	CHEM-105	CHEM-106
<b>1. Communication (Written and Oral)</b> Students will communicate effectively in writing and in speech, and interpret the written and oral expressions of others.	X	X
<b>2. Critical Thinking</b> Students will practice analytical and evaluative thinking with a view toward continuous improvement.	X	X
<b>3. Quantitative and Scientific Reasoning</b> Students will apply mathematical and scientific concepts and theories to identify and analyze problem-solving situation.	X	X
<b>4. Information &amp; Technology Literacy</b> Students will research, create, and communicate information through appropriate technology.	X	X
<b>5. Creativity</b> Students will explore and appreciate the creative processes that shape the human experience.		
<b>6. Global Awareness</b> Students will acknowledge and comprehend the beliefs, behaviors, and values of diverse populations within a global environment.		
<b>7. Personal Development and Social Responsibility</b> Students will recognize and engage in personal and social behaviors responsible for the wellness of self and community.	X	X

<b>Academic Discipline: Social Science</b>	<b>ANTH-101</b>	<b>ANTH-201</b>	<b>CRIM-101</b>	<b>ECON-102</b>	<b>GEOG-105</b>	<b>POLS-101</b>	<b>PSYC-101</b>	<b>SOC-101</b>	<b>SOC-110</b>
<b>1. Communication (Written and Oral)</b> Students will communicate effectively in writing and in speech, and interpret the written and oral expressions of others.	X	X	X	X	X	X	X	X	X
<b>2. Critical Thinking</b> Students will practice analytical and evaluative thinking with a view toward continuous improvement.	X	X	X	X	X	X	X	X	X
<b>3. Quantitative and Scientific Reasoning</b> Students will apply mathematical and scientific concepts and theories to identify and analyze problem-solving situation.	X		X	X	X	X	X	X	
<b>4. Information &amp; Technology Literacy</b> Students will research, create, and communicate information through appropriate technology.	X	X			X	X	X	X	X
<b>5. Creativity</b> Students will explore and appreciate the creative processes that shape the human experience.	X		X						
<b>6. Global Awareness</b> Students will acknowledge and comprehend the beliefs, behaviors, and values of diverse populations within a global environment.	X	X	X	X	X			X	X
<b>7. Personal Development and Social Responsibility</b> Students will recognize and engage in personal and social behaviors responsible for the wellness of self and community.	X	X	X	X	X			X	X