

Learning Goals and Outcomes: General Science Concentration

Our departmental evaluation of the degree to which students are achieving our learning outcomes, which is intended primarily as a tool for us to assess the effectiveness of our program, will take place primarily during their involvement in GNSC 0383: Senior Seminar in General Science. In that course, each student will assemble a portfolio documenting their achievements during their college career. We anticipate that the portfolio will include a section related to each of the goals identified below, with each section being introduced by a narrative that describes the materials presented, links them to specific outcomes, and assesses the student's achievement of each outcome. While we expect that most students will be able to provide appropriate supporting evidence from their coursework, in some cases (e.g. if the student did poorly on assignments related to particular outcomes) it would be appropriate for them to include additional essays summarizing their understanding of the material related to a particular outcome. The tables below also include a description of the standard that will be used in determining whether or not students have met each outcome.

Goal #1: Students will have a solid understanding of the basic principles of astronomy, biology, chemistry, geology, meteorology and physics and be able to apply their knowledge in those areas across traditional subject-matter boundaries.

| Learning Outcome | Method of Assessment | Standard for "Meets" | Courses (ELED) | Courses (5-8) |
|---|--|---|----------------|---------------|
| 1.01 Students will have demonstrated the ability to describe the components and overall structure of the Universe, including planets, the solar system, stars, the Milky Way and other galaxies, and the Universe at large. | Students will submit responses to exam questions, homework problems or class activities where they have utilized this knowledge. | Narrative and submitted work show clear understanding of the overall structure of the Universe (solar system, Milky Way, Local Group, Universe of galaxies), and include brief explanations of the nature of planets, stars, and galaxies. | ASTR 0101 | ASTR 0101 |
| 1.02 Students will have demonstrated the ability to describe the physical and chemical evolution of the Universe from the Big Bang to the present. | Students will submit responses to exam questions, homework problems or class activities where they have utilized this knowledge. | Narrative and submitted work provide an explanation of the Big Bang and the evidence supporting it (at least two of: cosmic background radiation, expansion of the Universe, elemental abundances), plus the formation of galaxies, and the formation of our solar system <u>and</u> provide a reasonable time scale for those events. Narrative and submitted work also shows a clear understanding of how nuclear fusion reactions inside stars have modified the original chemical composition of the Universe through time. | ASTR 0101 | ASTR 0101 |

Learning Goals and Outcomes: General Science Concentration

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| <p>1.03 Students will have demonstrated the ability to describe basic cellular structure and cellular processes.</p> | <p>Students will submit responses to exam questions, homework problems or class activities where they have utilized this knowledge.</p> | <p>Narrative and submitted work show that the student can distinguish between prokaryotic and eukaryotic cells, and also demonstrate an understanding of the major features of prokaryotic and eukaryotic cells, including the differences between animal and plant cells and the roles of the organelles present in eukaryotic cells.</p> | <p>BIOL 0104</p> | <p>BIOL 0129</p> |
| <p>1.04 Students will have demonstrated the ability to explain the process of genetic inheritance and the impacts of mutations and environmental conditions on that process.</p> | <p>Students will submit responses to exam questions, homework problems or class activities where they have utilized this knowledge.</p> | <p>Narrative and submitted work reflect an understanding of the mechanism by which genetic information is transmitted in the form of DNA. Evidence includes explanations of sexual and asexual transmission of genetic material, dominant and recessive genes, the importance of base pairing, and the role of mutation and environment.</p> | <p>BIOL 0104</p> | <p>BIOL 0128 BIOL 0129</p> |
| <p>1.05 Students will have demonstrated the ability to explain the theory of evolution and to describe some of the evidence that supports it.</p> | <p>Students will submit responses to exam questions, homework problems or class activities where they have utilized this knowledge.</p> | <p>Narrative and submitted work demonstrate a clear understanding of the idea of “natural selection” operating to change the overall characteristics of species, and provide discussions of at least two kinds of evidence that support the idea that evolution can take place or has taken place (e.g. artificial selection, vestigial organs, homologous structures, fossil sequences).</p> | <p>BIOL 0104 GEOL 0106</p> | <p>BIOL 0128 GEOL 0106</p> |
| <p>1.06 Students will have demonstrated the ability to explain the basic functions of ecosystems, including an understanding of the interactions between organisms and the factors that influence population sizes for various organisms.</p> | <p>Students will submit responses to exam questions, homework problems or class activities where they have utilized this knowledge.</p> | <p>Narrative and submitted work reflect an understanding of the functioning of ecosystems, including the interactions between different types of organisms (primary producers, herbivores, carnivores, decomposers, etc.) and between organisms and their physical environment.</p> | <p>BIOL 0102</p> | <p>BIOL 0128</p> |

Learning Goals and Outcomes: General Science Concentration

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| <p>1.07 Students will have demonstrated the ability to explain the structure of matter (including molecules, atoms, and nuclei), and to distinguish between solids, liquids, gases, and solutions.</p> | <p>Students will submit responses to exam questions, homework problems or class activities where they have utilized this knowledge.</p> | <p>Narrative and submitted work reflect an understanding of atomic and molecular structure, and the forces that determine whether a substance exists as a solid, liquid or gas.</p> | <p>CHEM 0101 PHSC 0101</p> | <p>CHEM 0109 CHEM 0111</p> |
| <p>1.08 Students will have demonstrated the ability to describe some of the chemical and physical properties, and trends in those properties, of elements based on their position in the periodic table.</p> | <p>Students will submit responses to exam questions, homework problems or class activities where they have utilized this knowledge.</p> | <p>Narrative and submitted work reflect an understanding of the organization of the periodic table by various classifications and the similarities or trends in chemical and physical properties within those classifications.</p> | <p>CHEM 0101</p> | <p>CHEM 0109 CHEM 0111</p> |
| <p>1.09 Students will have demonstrated the ability to interpret chemical equations and to make stoichiometric calculations.</p> | <p>Students will submit responses to exam questions, homework problems or class activities where they have utilized this knowledge.</p> | <p>Narrative and submitted work reflect the ability to write and balance chemical equations and make basic stoichiometric calculations relating reactants to products.</p> | <p>CHEM 0101</p> | <p>CHEM 0109 CHEM 0111</p> |
| <p>1.10 Students will have demonstrated the ability to explain acid-base chemistry, including the use of appropriate net ionic equations.</p> | <p>Students will submit responses to exam questions, homework problems or class activities where they have utilized this knowledge.</p> | <p>Narrative and submitted work reflect the ability to identify acids and bases, write chemical equations that describe their acid-base chemistry, and perform simple acid-base calculations.</p> | <p>CHEM 0101</p> | <p>CHEM 0109 CHEM 0111</p> |

Learning Goals and Outcomes: General Science Concentration

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| <p>1.11 Students will have demonstrated the ability to describe oxidation-reduction reactions using appropriate chemical equations, to identify oxidation and reduction, and to apply those concepts to electrochemical cells.</p> | <p>Students will submit responses to exam questions, homework problems or class activities where they have utilized this knowledge.</p> | <p>Narrative and submitted work reflect an understanding of balancing oxidation-reduction chemical equations, identifying the oxidant and reductant, and designing simple electrochemical cells.</p> | <p>CHEM 0101</p> | <p>CHEM 0109 CHEM 0111</p> |
| <p>1.12 Students will have demonstrated the ability to explain the basic laws of thermodynamics and to apply those laws to chemical reactions.</p> | <p>Students will submit responses to exam questions, homework problems or class activities where they have utilized this knowledge.</p> | <p>Narrative and submitted work reflect an understanding of enthalpy, entropy, and Gibbs free energy and how they relate to the spontaneity of a reaction.</p> | <p>Not applicable.</p> | <p>CHEM 0109 CHEM 0111 PHSC 0125</p> |
| <p>1.13 Students will have demonstrated the ability to describe the factors that control the rates of chemical reactions.</p> | <p>Students will submit responses to exam questions, homework problems or class activities where they have utilized this knowledge.</p> | <p>Narrative and submitted work reflect an understanding of how the concentrations of reactants and products, temperature, and presence of a catalyst control the rate of a chemical reaction.</p> | <p>Not applicable.</p> | <p>CHEM 0111</p> |
| <p>1.14 Students will have demonstrated the ability to explain the theory of plate tectonics and to recognize features associated with different styles of plate boundaries.</p> | <p>Students will submit responses to exam questions, homework problems or class activities where they have utilized this knowledge.</p> | <p>Narrative and submitted work demonstrate a clear understanding of the production and recycling of sea floor resulting from the gradual cooling of Earth's interior, and correctly relate mid-ocean ridges, deep ocean trenches, volcanic mountain ranges, volcanic island arcs, and earthquakes to the appropriate styles of plate boundary.</p> | <p>GEOL 0101 GEOL 0106</p> | <p>GEOL 0101 GEOL 0106</p> |

Learning Goals and Outcomes: General Science Concentration

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| <p>1.15 Students will have demonstrated the ability to describe Earth’s physical history, including its formation, the history of continental motions, and changing surface environments (e.g. “ice ages”).</p> | <p>Students will submit responses to exam questions, homework problems or class activities where they have utilized this knowledge.</p> | <p>Narrative and submitted work demonstrate a clear understanding of the broad outlines of the Earth’s history, including a description of the process of Earth’s formation, a recognition of the former existence of the supercontinents Rodinia and Pangaea and the role of paleomagnetism in unraveling the history of those continental motions, and a description of the extent of both the snowball Earth episodes of the late Proterozoic and the more recent Quaternary ice ages.</p> | <p>GEOL 0106</p> | <p>GEOL 0106</p> |
| <p>1.16 Students will have demonstrated the ability to describe the history of life on Earth, including its origin, the variety of organisms that have inhabited the planet, and major events that have affected life.</p> | <p>Students will submit responses to exam questions, homework problems or class activities where they have utilized this knowledge.</p> | <p>Narrative and submitted work demonstrate a clear understanding of the broad outlines of the history of life on Earth, including some discussion of current ideas on the origin of life, and at least five major events in the history of life: the development of eukaryotes, the Cambrian explosion, the Permian-Triassic extinction, the K-T extinction, and the evolution of humans, and the approximate times at which those events occurred.</p> | <p>GEOL 0106</p> | <p>GEOL 0106</p> |
| <p>1.17 Students will have demonstrated the ability to describe the Earth’s atmosphere and climate, and to discuss the physical and chemical factors that control those features of our planet.</p> | <p>Students will submit responses to exam questions, homework problems or class activities where they have utilized this knowledge.</p> | <p>Narrative and submitted work demonstrate an understanding of weather systems (including fronts, tornadoes and hurricanes) and the roles of solar heating, Earth’s rotation and the oceans in determining climatic patterns on Earth’s surface.</p> | <p>GARP 0230</p> | <p>GARP 0230</p> |
| <p>1.18 Students will have demonstrated the ability to explain Newton’s laws of motion and to apply those laws to situations involving a variety of kinds of forces, including gravitational, electrostatic and magnetic.</p> | <p>Students will submit responses to exam questions, homework problems or class activities where they have utilized this knowledge.</p> | <p>Narrative and submitted work provide examples of the application of each of Newton’s laws of motion and show a familiarity with the concepts of speed, velocity, and acceleration. Student work includes examples of the use of free-body diagrams to show the forces acting on an object, and at least one example involving each of the following forces: frictional, centripetal, gravitational, electrostatic and magnetic forces.</p> | <p>PHSC 0101</p> | <p>PHSC 0115 PHSC 0117</p> |

Learning Goals and Outcomes: General Science Concentration

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| <p>1.19 Students will have demonstrated the ability to explain the nature of conservation laws in physics and chemistry (e.g. energy, momentum, atoms), and to apply those ideas in a variety of situations.</p> | <p>Students will submit responses to exam questions, homework problems or class activities where they have utilized this knowledge.</p> | <p>Narrative and submitted work provide examples that illustrate the laws of conservation of momentum and energy, including familiarity with the concepts of work, kinetic energy, gravitational potential energy, and electrical potential energy.</p> | <p>PHSC 0101</p> | <p>CHEM 0109 PHSC 0115</p> |
| <p>1.20 Students will have demonstrated the ability to explain basic principles of electricity and magnetism, and to apply those ideas to simple electrical circuits and devices.</p> | <p>Students will submit responses to exam questions, homework problems or class activities where they have utilized this knowledge.</p> | <p>Narrative and submitted work demonstrate an understanding of the parameters for simple electrical circuits (voltage, current, resistance, power) and of Ohm's Law and its application to both series and parallel circuits.</p> | <p>PHSC 0101</p> | <p>PHSC 0117</p> |
| <p>1.21 Students will have demonstrated the ability to describe wave phenomena, including an explanation of the properties of sound and light.</p> | <p>Students will submit responses to exam questions, homework problems or class activities where they have utilized this knowledge.</p> | <p>Narrative and submitted work demonstrate a clear understanding of the different types of waves (transverse, longitudinal), the properties of waves (velocity, frequency, wavelength, amplitude, period) and some important wave behaviors (reflection, refraction, interference, Doppler effect).</p> | <p>PHSC 0101</p> | <p>CHEM 0109 PHSC 0117</p> |

Learning Goals and Outcomes: General Science Concentration

Goal #2: Students will develop effective laboratory skills and will understand safety issues related to laboratory and field work.

| Learning Outcome | Method of Assessment | Standard for “Meets” | Courses (ELED) | Courses (5-8) |
|--|---|--|-------------------------------------|---|
| 2.01 Students will have demonstrated the ability to perform a variety of measurements, using a variety of instruments and an awareness of the uncertainties inherent in any measurement. | Students will submit laboratory reports for which they made appropriate measurements. | Narrative and submitted work include instances where the student performed at least six different kinds of measurements, and demonstrates an understanding of the errors associated with those measurements. | CHEM 0101 PHSC 0101 | CHEM 0109 CHEM 0111 PHSC 0115 PHSC 0117 |
| 2.02 Students will have demonstrated the ability to perform a variety of basic procedures in the chemistry lab (e.g. weighing samples, titration, etc.). | Students will submit laboratory reports or notebooks showing that they have performed such procedures correctly. | Narrative and submitted work demonstrate an understanding of several procedures, including determining sample mass, titration, and determining pH. | CHEM 0101 | CHEM 0109 CHEM 0111 |
| 2.03 Students will have demonstrated the ability to keep accurate and detailed records of what was done during experiments. | Students will submit laboratory reports demonstrating these abilities. | Narrative reflects an understanding of the record-keeping needed for laboratory work. Submitted work includes at least one laboratory report, for a moderately involved experiment, that demonstrates these abilities. | CHEM 0101 PHSC 0101 | CHEM 0109 CHEM 0111 PHSC 0115 PHSC 0117 |
| 2.04 Students will have demonstrated the ability to use up-to-date teaching technologies (e.g. computer software, motion detectors, PowerPoint, etc.). | Students will submit copies of laboratory exercises or presentations where such skills were used. | Narrative and submitted work provide at least three examples of situations where students have made successful use of such technologies, including at least one PowerPoint presentation that the student assembled. | PHSC 0101 | PHSC 0115 |
| 2.05 Students will have demonstrated the ability to explain the rationale for basic principles of safety for laboratory and/or field work, including the use of material safety data sheets (MSDSs). | Students will submit a reflective paragraph in which they describe laboratory or field experiences where they took appropriate safety precautions and the need for those precautions. | Narrative will include at least three different situations (one each from physics, chemistry and geology) where students demonstrate an understanding of safety issues, including at least one situation where they demonstrate a familiarity with the use of MSDSs. | CHEM 0101 GEOL 0101 PHSC 0101 | CHEM 0109 CHEM 0111 GEOL 0101 PHSC 0115 PHSC 0117 |

Learning Goals and Outcomes: General Science Concentration

Goal #3: Students will understand the methodology and processes of science, and will be able to explain the differences between scientific and other ways of knowing.

| Learning Outcome | Method of Assessment | Standard for “Meets” | Courses (ELED) | Courses (5-8) |
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| 3.01 Students will have demonstrated the ability to use the methodology of science, including the processes of observation, forming hypotheses, making predictions based on hypotheses, testing of those predictions, and evaluation of the results. | Students will submit laboratory reports where they have engaged in the various processes, along with a reflective narrative discussing the processes of science and linking their specific reports to each process. | Narrative and submitted work reflect a clear understanding of the methodology of science and submitted work includes laboratory reports that provide at least one example for each of the processes where the student successfully engaged in that process. | CHEM 0101 GEOL 0101 PHSC 0101 | CHEM 0109 CHEM 0111 GEOL 0101 PHSC 0115 PHSC 0117 |
| 3.02 Students will have demonstrated the ability to distinguish between hypotheses and scientific theories, | Students will submit a reflective paragraph in which they discuss the difference between hypotheses and theories. | Narrative demonstrates an understanding of the difference between hypotheses and scientific theories. | ASTR 0101 CHEM 0101 GEOL 0101 GEOL 0106 PHSC 0101 | ASTR 0101 CHEM 0109 CHEM 0111 GEOL 0101 GEOL 0106 PHSC 0115 |
| 3.03 Students will have demonstrated the ability to explain some of the evidence that underpins major theories from the physical sciences (e.g. plate tectonics, relativity, the Big Bang). | Students will submit responses to exam questions, homework problems or class activities where they have explained such evidence. | Narrative and submitted work demonstrate a clear understanding of the evidence that supports at least five major scientific theories (including at least one theory from each of the general science disciplines: astronomy, biology, chemistry, geology, and physics). | ASTR 0101 CHEM 0101 GEOL 0101 GEOL 0106 PHSC 0101 | ASTR 0101 CHEM 0109 CHEM 0111 GEOL 0101 GEOL 0106 PHSC 0115 PHSC 0117 |
| 3.04 Students will have demonstrated the ability to explain the nature of scientific “truth” and to compare scientific knowledge to other kinds of knowledge (e.g. political, religious, artistic). | Students will submit answers to exam questions or papers demonstrating their knowledge of the nature of science, along with a reflective paragraph in which they compare scientific knowledge with other kinds. | Narrative and submitted work demonstrate familiarity with the nature of scientific knowledge, and show that the student has considered the similarities and differences between scientific knowledge and other kinds of knowledge. | GNSC 0330 | GNSC 0330 |

Learning Goals and Outcomes: General Science Concentration

Goal #4: Students will be able to relate their scientific knowledge to both the natural and technological worlds around them, and will be able to apply those understandings to develop informed opinions about societal issues with a scientific component.

| Learning Outcome | Method of Assessment | Standard for “Meets” | Courses (ELED) | Courses (5-8) |
|---|---|--|--|--|
| 4.01 Students will have demonstrated the ability to provide specific examples of situations where scientific principles can explain particular events in the natural world. | Students will submit responses to exam questions or homework problems that demonstrate their ability to make such explanations. | Narrative and submitted work demonstrate an understanding of at least five natural phenomena based on scientific principles. | ASTR 0101 BIOL 0102 BIOL 0104 CHEM 0101 GEOL 0101 GEOL 0106 GNSC 0330 PHSC 0101 | ASTR 0101 BIOL 0128 BIOL 0129 CHEM 0109 CHEM 0111 GEOL 0101 GEOL 0106 GNSC 0330 PHSC 0115 PHSC 0117 |
| 4.02 Students will have demonstrated the ability to provide specific examples of devices where certain scientific principles are utilized. | Students will submit responses to exam questions or homework problems that demonstrate their knowledge of such applications. | Narrative and submitted work demonstrate an understanding of at least three technological applications of basic principles of chemistry and/or physics. | GNSC 0330 PHSC 0101 | GNSC 0330 PHSC 0115 PHSC 0117 |
| 4.03 Students will have demonstrated the ability to defend positions on issues like global warming, the disposal of radioactive waste, acid rain, or the use of pesticides. | Students will submit responses to exam questions or papers where they have defended a position on an issue with a scientific component. | Narrative and submitted work identify at least two social/environmental issues with a scientific component, demonstrate an understanding of the basic scientific principles that are involved, and support a position on each of those issues with at least two plausible arguments. | GEOL 0101 GNSC 0330 PHSC 0101 | GEOL 0101 GNSC 0330 |

Learning Goals and Outcomes: General Science Concentration

Goal #5: Students will be able to locate, evaluate and synthesize information on scientific topics that are new to them.

| Learning Outcome | Method of Assessment | Standard for “Meets” | Courses (ELED) | Courses (5-8) |
|--|---|--|--|--|
| 5.01 Students will have demonstrated the ability to retrieve information effectively from libraries, electronic databases, and internet resources. | Students will submit copies of papers or other assignments where they retrieved information from a variety of sources. | Narrative and submitted work document at least one instance where the student has retrieved information from each of the sources listed. | ASTR 0349 or GEOL 0347 GNSC 330 | ASTR 0349 or GEOL 0347 GNSC 330 |
| 5.02 Students will have demonstrated the ability to evaluate the credibility and relevance of sources of scientific information. | Given a set of potential sources for information on a scientific topic, students will write a brief essay evaluating those sources. | Narrative documents an understanding of the likely reliability of different types of sources. | GNSC 0330 | GNSC 0330 |
| 5.03 Students will have demonstrated the ability to compare and synthesize information on a topic from a variety of sources. | Students will submit copies of papers or other assignments where they synthesized information. | Narrative and submitted work demonstrate at least one instance where the student has brought together information from a variety of sources to arrive at a more nuanced understanding of some topic. | ASTR 0349 or GEOL 0347 GNSC 330 | ASTR 0349 or GEOL 0347 GNSC 330 |

Learning Goals and Outcomes: General Science Concentration

Goal #6: Students will be able to make effective use of mathematical reasoning, including the ability to apply algebraic skills to solve scientific problems or to make quantitative estimates.

| Learning Outcome | Method of Assessment | Standard for “Meets” | Courses (ELED) | Courses (5-8) |
|---|--|--|--|---|
| 6.01 Students will have demonstrated the ability to construct graphs from available data and to use those graphs to analyze and understand the phenomenon being investigated. | Students will submit homework problems or laboratory reports where they have demonstrated these skills. | Narrative and submitted work include at least two examples of situations where the student has demonstrated the ability to construct a graph, reason about the phenomenon based on a graphical representation of data, and has interpreted characteristics of the graph (e.g. the slope of a best-fit line). | ASTR 0349 or GEOL 0347 PHSC 0101 | ASTR 0349 or GEOL 0347 PHSC 0115 PHSC 0117 |
| 6.02 Students will have demonstrated the ability to solve algebraic equations for an unknown quantity and to calculate that quantity given appropriate information. | Students will submit exam questions and/or homework problems where they have demonstrated these skills. | Narrative and submitted work include at least five examples (involving five different equations) of situations where the student has demonstrated these skills. | ASTR 0101 ASTR 0349 or GEOL 0347 PHSC 0101 | ASTR 0101 ASTR 0349 or GEOL 0347 PHSC 0115 PHSC 0117 |
| 6.03 Students will have demonstrated the ability to make “back of the envelope” calculations to estimate quantities of interest (e.g. the volume of Earth’s atmosphere). | Students will submit exam questions, homework problems, or class activities where they have demonstrated these skills, OR will solve such a problem on demand. | Narrative and submitted work includes at least two examples of situations where the student has successfully estimated the order of magnitude for some quantity based on their general knowledge. | ASTR 0101 ASTR 0349 or GEOL 0347 | ASTR 0101 ASTR 0349 or GEOL 0347 |
| 6.04 Students will have demonstrated the ability to use dimensional analysis to determine the appropriate units for an unknown quantity. | Students will submit exam questions, laboratory reports, and/or homework problems where they have demonstrated this skill, along with a reflective paragraph in which they discuss the usefulness of dimensional analysis. | Narrative and submitted work includes at least two examples of problems where the student was able to work out the units for an unknown quantity. Reflective paragraph demonstrates a reasonable understanding of the usefulness of dimensional analysis. | PHSC 0101 | PHSC 0115 PHSC 0117 |

Learning Goals and Outcomes: General Science Concentration

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| 6.05 Students will have demonstrated the ability to use spreadsheets to organize and analyze data. | Students will submit homework problems or laboratory reports where they have demonstrated this skill. | Narrative and submitted work provides at least one example of a situation where the student successfully used a spreadsheet to help with the organization and analysis of data. | ASTR 0349 or GEOL 0347 | ASTR 0349 or GEOL 0347 PHSC 0117 |
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Learning Goals and Outcomes: General Science Concentration

Goal #7: Students will develop effective written and oral communication skills, including the ability to compose summaries, develop research papers or persuasive essays, and present the results of their own scientific investigations.

| Learning Outcome | Method of Assessment | Standard for “Meets” | Courses (ELED) | Courses (5-8) |
|--|--|---|---|--|
| 7.01 Students will have demonstrated the ability to write brief (1-page) summaries focused on the major points made in an article or during a presentation. | Students will submit examples of such summaries. | Submitted work (which includes the article being summarized) demonstrates an understanding of the article’s major points and of the observations or arguments that the author has used to support those major points. | GEOL 0106 GNSC 0330 | GEOL 0106 GNSC 0330 |
| 7.02 Students will have demonstrated the ability to prepare clear and complete laboratory reports, including a description of their procedure, their data and an interpretation of that data. | Students will submit copies of laboratory reports demonstrating these qualities, along with comments/grades from their instructor. | Narrative reflects an understanding of the need for careful observation and record-keeping during experiments. Submitted work includes at least two examples of laboratory reports demonstrating these competencies. | CHEM 0101 PHSC 0101 | CHEM 0109 CHEM 0111 PHSC 0115 PHSC 0117 |
| 7.03 Students will have demonstrated the ability to write an informational research paper, summarizing what is known about a scientific topic, making appropriate use of in-text and bibliographic references. | Students will submit such a paper and relevant comments/grade from the instructor. | Submitted work includes at least one research paper (at least 3 pages in length), on a scientific topic, that includes appropriate bibliographic and in-text citations. | ASTR 0349 or GEOL 0347 GNSC 0330 | ASTR 0349 or GEOL 0347 GNSC 0330 |
| 7.04 Students will have demonstrated the ability to write an effective persuasive essay, in which they argue for a particular point of view on a topic that involves scientific information. | Students will submit such an essay and relevant comments/grade from the instructor. | Submitted work includes at least one persuasive essay on a topic that involves some scientific content. | GNSC 0330 | GNSC 0330 |
| 7.05 Students will have demonstrated the ability to make a well-organized oral presentation on a scientific topic using appropriate technology (e.g. PowerPoint). | Students will include such a presentation (paper copy of slides or a CD), along with comments/grade from the instructor. | Submitted work includes at least one well-organized PowerPoint presentation that the student gave, appropriately documented. | GNSC 0330 | GNSC 0330 |

Learning Goals and Outcomes: General Science Concentration

Goal #8: Students will develop habits of mind that promote their curiosity about the world around them, their expectation that they should be able to make sense of that world, and their ability to monitor their own understanding.

| Learning Outcome | Method of Assessment | Standard for “Meets” | Courses (ELED) | Courses (5-8) |
|---|---|--|------------------------|------------------------|
| 8.01 Students will have demonstrated the ability to notice things about the natural world (the phase of the moon, the discharge of a river, etc.) and attempt to fit those observations into their base of formal knowledge. | Students will include a reflective paragraph in which they recount an experience where they noticed something new and attempted to explain it. | Narrative includes such a paragraph, where the student documents a situation where they noticed something and attempted to understand their observation in terms of their scientific knowledge. | GNSC 0330 | GNSC 0330 |
| 8.02 Students will have demonstrated that they have maintained an awareness of new developments in the sciences by watching or listening to news or informational programs on television or radio, or by regularly reading appropriate newspapers or magazines. | Students will submit a list of articles they read or programs they watched during a recent semester, and will write a reflective paragraph in which they assess their level of engagement with new developments in science. | Narrative includes such a list (that contains at least three articles from scientifically-focused magazines – e.g. Scientific American) and an appropriate reflective paragraph. | GNSC 0330 | GNSC 0330 |
| 8.03 Students will have demonstrated the ability to reflect on their understanding of new topics, identifying areas where they need additional information to achieve an adequate level of comprehension. | Students will include a reflective paragraph where they evaluate their knowledge of some topic they’ve encountered recently. | Narrative includes such a reflective paragraph that discusses a topic they’ve come across within the past few months, offers an assessment of their understanding, and indicates areas where they might want to seek additional information. | GNSC 0330 GNSC 0383 | GNSC 0330 GNSC 0383 |
| 8.04 Students will have demonstrated the ability to pursue understanding by seeking additional information about areas where they recognize their understanding to be incomplete. | Students will include a reflective paragraph in which they describe a recent situation where they’ve sought additional information about a topic they’ve recently encountered. | Narrative includes such a reflective paragraph and provides a reasonable example of such a situation, with a brief summary of the additional information that they obtained. | GNSC 0330 GNSC 0383 | GNSC 0330 GNSC 0383 |

Learning Goals and Outcomes: General Science Concentration

The grid below summarizes how the major coursework contributes to the individual goals described above for students in the GNSC concentration, elementary-school track and GNSC concentration, middle-school track:

| | Astronomy | Biology Courses | Intro to Chemistry | General Chemistry I | General Chemistry II | Physical Geology | Historical Geology | Meteorology | Intro to Physics | General Physics I | General Physics II | Science, Tech, Society | IIPS: Astronomy | IPS: Geology |
|---------------------------------|-----------|-----------------|--------------------|---------------------|----------------------|------------------|--------------------|-------------|------------------|-------------------|--------------------|------------------------|-----------------|--------------|
| 1. Basic principles | X | X | X | X | X | X | X | X | X | X | X | | X | X |
| 2. Laboratory skills | | X | X | X | X | X | | | X | X | X | | | |
| 3. Methodology of science | X | | X | X | X | X | X | | X | X | X | X | | |
| 4. Apply to social issues | X | X | X | X | X | X | X | | X | X | X | X | | |
| 5. Locate, evaluate, synthesize | | | | | | | | | | | | X | X | X |
| 6. Mathematical reasoning | X | | | | | X | | | X | X | X | | X | X |
| 7. Written communication | | | X | X | X | | X | | X | X | X | X | X | X |
| 8. Habits of mind | | | | | | | | | | | | X | | |