

The Scientific Enterprise

NSM 202 Section A | Fall 2014 | MW 8:00 a.m. – 10:00 a.m. | KOSC 214



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blackboard.gordon.edu

Office Hours:
MWF 12:30-2pm
by appointment



Course Materials

- **Required Books:**
 - Hazen, Robert and Trefil, James. *Science Matters: Achieving scientific literacy*, NY: Anchor Books, 2009.
 - Muller, Richard. *Physics for Future Presidents: The science behind the headlines*, NY: W.W. Norton, 2008.
 - Collins, Francis. *The Language of God*, NY: Free Press, 2006.
- **Other course materials and readings will be available on the course website.**



Course Description

Science, through its methods of rational inquiry, has proven to be a very powerful and extremely effective way to discover knowledge about the natural world. An appreciation for the natural sciences and for the technological outworking of science can make profound contributions to how we know the Creator, can enrich how we understand and advance our Faith in the world and can enhance how effectively we support Christian values and leadership in all areas of society.

The Scientific Enterprise explores the essential methods and processes that characterize the human endeavor we call science. Students are invited to *actively participate* in the process of scientific inquiry, employing scientific and quantitative reasoning skills, as they explore some of the significant issues confronting our society, referencing and utilizing many of the important understandings and ideas of science and technology. Students are also invited to consider the importance of being a scientifically literate citizen in our democratic society and are encouraged to pursue a lifelong quest for such literacy. Reflection on the interconnectedness of the knowledge afforded by the scientific enterprise and the reconciliation of this knowledge with Scripture and various religious traditions will strive to support development of a comprehensive Christian view of the natural world.

Through theory and practice, utilizing logical analysis and creative intuition, *The Scientific Enterprise* invites students to explore descriptive, explanatory and predictive insights about the natural world that are both compelling and powerful. Students are encouraged and supported to consider the implications of such knowledge, appreciate its relevance and reflect on the responsibilities such knowledge requires of individuals and of society.

Acts 17:11 Now these were more noble than those in Thessalonica, in that they received the word with all readiness of the mind, examining the Scriptures daily, whether these things were so.

American Standard Version (ASV)



Objectives and Learning Outcomes

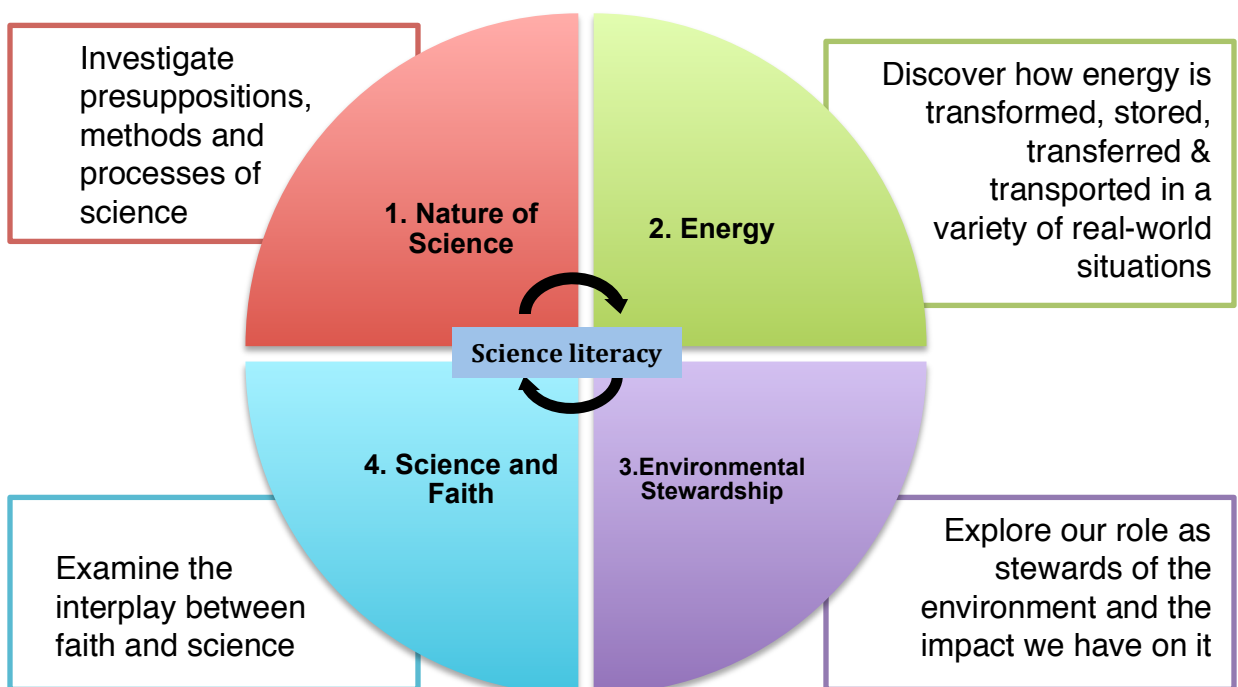
The Scientific Enterprise seeks to:

1. encourage and support understanding and appreciation of the distinguishing characteristics of natural science and the scientific enterprise
 - the presuppositions that underpin the scientific enterprise,
 - scientific methods for discovering new knowledge about the physical world,
 - processes by which scientific understanding advances and is accepted,
 - the strengths, limitations and self-correcting nature of science;
 - the essential connection between science and technology; how each is informed by, relies upon and proceeds from the other.
2. invite and facilitate understanding of some of the important concepts and theories of natural science, through exploration of the rich and varied patterns and processes found in the natural world.
3. promote appreciation for the need for scientific literacy and provide guidance as to how students may discern and make wise decisions regarding scientific issues; and
4. facilitate consideration of the proper place of nature and the scientific enterprise within a Christian worldview.



Course Structure

This course consists of four modules: (1) the nature, methods and processes of science; (2 & 3) the application of science reflected in current issues of *energy* and *environmental stewardship*; and (4) the conciliation of faith and science. Technology, which can either facilitate scientific advance or become the visible outworking of such advances, will be addressed and referenced throughout the course.





Pedagogy

Science education research has identified principles and methods that foster more effective learning. In principle, learning increases as students actively engage the material and receive timely feedback about their progress.

Methods employed to foster a more effective learning experience will include a variety of active inquiry (hands-on) and peer learning exercises, integrated lecture-demonstrations and guided classroom discussions. All of the material in the course will be presented in association with context rich issues that are highly relevant to students and modern society, placing the scientific enterprise in a framework that illustrates how science and technology inform and contribute to significant decisions that must be made by various individual, corporate and governmental constituencies.

Formative assessment methods that engage students and provide regular, real-time feedback about student progress will be employed. These include, but are not limited to, the use of “concept tests” during course sessions, interactive problem solving exercises and short reflection papers in preparation for classroom discussions or in reaction to assigned reading. An important pedagogical innovation will be the integration of the traditional lecture and science laboratory/activity experiences, so that hands-on inquiry using the methods and instruments of science occur seamlessly and coincident with student engagement of the relevant theories and concepts.

Effort will be made to establish a class environment that invites you to participate. At times this will be accomplished through interactive demonstrations, peer collaborative learning experiences and classroom discussions. At other times your participation will be invited utilizing a personal response system (PRS), consisting of either a card with letter and number responses or an electronic “clicker”. The instructor will determine the specific system to be used in each course section.



Assignments & Evaluation

Evaluation: Grades will be assigned as follows: 93 or greater = A; 90 – 92 = A⁻; 87 – 89 = B⁺; 83 – 86 = B; etc. Please note that grades may be carried to one or two decimal places. If so, you must reach the appropriate cutoff in order to receive a grade. Grades will not be rounded up or down. The confidentiality of student grades is respected. In order to provide each student with current access to his or her individual grades, while maintaining confidentiality, grades will be posted from time-to-time on the password protected Blackboard site where each student may access his or her grades.

Course success will be assessed in the following weighted categories:

Participation (10%): Active participation is so important that we will be basing 10% of your final grade on such active engagement. Criteria for the grade will include class attendance, active and effective use of the PRS system (both responding and responding correctly to questions based upon homework assigned and material presented in course sessions), quiz results and willingness to actively participate in other ways during classroom activities. Both the quality and consistency of participation will be considered in assigning a grade.

The assigned grade for participation will be based upon the cumulative attendance and participation results, modified by the instructor’s assessment of how effectively you have actively engaged in the course. In order to accommodate varsity athletic competitions, illness, field trips, emergencies, and personal situations that result in an absence from a course session, each student’s cumulative attendance/participation grade will be multiplied by a factor of 1.10 (with grades capped at 100% of the

maximum points allowed). As a result, students that are unable to attend all course sessions are still able to earn an A for participation.

Homework (20%): Homework will typically consist of an assignment asking you to read and interact with material in a book, article, or a video. It may also involve a written summary-reaction-response that must be submitted on-line or turned in at the beginning of a course session. On occasion you will be asked to work collaboratively with other students on an exercise or activity, and you may be asked to make an oral report or presentation to the class.

Please note that reading a science book may be very different than reading other types of written material. It is not sufficient to read the words. You must read to understand the concepts and principles being presented. Often this will include careful, simultaneous consideration of graphs, diagrams, tables, and other support material. It may even require you to reread a section a second time in order to comprehend the concepts or relationships being presented.

The homework you turn in must be substantially your own work. Although some discussion concerning the general approach to an assignment may take place with other students, the peer mentor, or the instructor, the actual work you submit must be your own. Please do not share your homework with others.

Homework will be collected at the beginning of course sessions (on-line submissions will not be possible after the start of class). Please place your name, the assignment name and the date the assignment is due at the top of each assignment. Late homework may be accepted at the discretion of the instructor, but there will be a deduction of points for each day it is late. You are expected make every effort to turn in homework on time, even if you are unable to attend a session.

Written homework will be graded based upon the (a) degree to which you are able to demonstrate reasonable command of the material, (b) care and thoughtfulness with which you present your responses, (c) organization of work and legibility of response, (d) completeness of response or solution, and, as applicable, (e) correct or acceptable response or solution. You should submit whatever homework you have completed.

Module Assignments (15%): There will be three major assignments: one for Module 1, one for Modules 2 and 3 and one for Module 4. Details of each assignment will be posted on Blackboard by the start of the module, so you will have time to work on it over the course of the module. An important objective of this course is to increase your level of scientific literacy, preparing you to make reasoned judgments about scientific developments. Scientific literacy requires familiarity with the terminology of science, learning and being able to apply basic scientific concepts, and understanding the strengths and limitations of the scientific process -- enabling you, as a citizen, to make informed decisions about science and technology and to participate in public discourse on scientific issues that affect our society. Please note three things carefully as you do these assignments:

- a. Be sure to read the assignment carefully, and do exactly what is assigned. In fact, you would do well to re-read the assignment after you've completed your initial work, to be sure you did the right thing!
- b. Each assignment will include a grading rubric at the end. Read this over carefully when doing the assignment, to be sure you've done everything listed in it.
- c. Don't wait until the last minute to do the assignment! These are meant to be major, integrative pieces of work.

Tests and Exam (55%): There will be four tests and a final cumulative exam. The fourth test and the cumulative exam will both be administered during the time designated for the final exam. Tests and the cumulative final exam may consist of a variety of question formats (multiple choice, true/false, matching, and both long and short response) designed to assess command of the concepts, command of facts, facility solving problems, ability to integrate science and societal issues, etc.

Time Commitment: Colleges with academic standards similar to Gordon typically recommend that students allocate about one and a half hours studying out-of-class for each hour in class. While there will be significant variation among students based upon previous preparation and individual goals, you should plan on spending an average of 6 hours per week studying for this course.



Our Policies

Course Sessions: Sessions may present you with new material, expand upon material in homework assignments, provide opportunities to practice and develop skills, demonstrate key principles, or serve as occasions for peer discussion and cooperative learning. Reading and other homework assignments are designed to introduce, reinforce and/or supplement material presented in course sessions. Most reading assignments are expected to be completed before coming to class. *Each student is responsible for all material assigned and all material presented in sessions.*

Attendance: Attendance (and timely arrival) at all sessions is expected. Athletes and others that have a scheduling conflict are expected to provide the instructor with a list of anticipated conflicts. In general, you will not be excused from tests. We have observed that few students do well in the core science courses without regular attendance. If you will miss a class session, please make arrangements with the instructor or another student to pick up hand outs, to turn in your homework when it is due, and to obtain the assignment for the next class session.

Electronic Devices: The classroom is a semi-sacred space where a learning community assembles to attend to each other and to the subject matter (the Creation). In the interest of maintaining an environment conducive to the purposes of this course, cell phone use and texting are not permitted in class. Please turn off your phone and put it away (out of sight) before entering class. Laptop computer use is limited to activities related to the class in session at the time (e.g., taking notes, consulting assigned material, or accessing materials being presented and used in the class). Laptops may not be used for activities pertaining to another course or non-academic purposes (including, but not limited to e-mail, surfing the web, playing games, social networking, etc.)

Accommodations: Students with disabilities who need academic accommodation are asked to speak with the instructor within the first two weeks of class. Students are also responsible for making sure that documentation of the disability is on file in the Academic Support Center. Failure to register in time with the professor and the ASC may compromise our ability to provide the accommodation.

Academic Dishonesty: Academic dishonesty is regarded as a major violation of both the academic and spiritual principles of this community and may result in a failing grade or suspension. Academic dishonesty includes plagiarism, (see Plagiarism in Student Handbook), cheating (whether in or out of the classroom), and abuse or misuse of library materials when such abuse or misuse can be related to course requirements.

Library Resources: Students are responsible to obtain any library resources assigned for this course. Questions about library resources should be directed to librarians in the Jenks Library. Librarians are available to assist you from the library reference desk, by e-mail at library@gordon.edu, or by phone (978) 867-4878.

Notices: Notices about changes in procedure, schedule adjustments, tutorial sessions, and other course related matters may be provided in class, distributed by e-mail, or may also be posted on the course Blackboard site. If there is an urgent notice, or one that is time sensitive, an e-mail will be sent to each member of the class.



Module 1: Learning Outcomes & Schedule

By the end of Module 1, you will be able to:

- Describe the basic nature of science: what it means that science is both durable and subject to change, as well as its limitations in dealing with philosophical questions.
- Understand how science has changed over time, and how science progresses including the concept of “normal science” and “paradigm shifts”
- Focus on a major scientific theory that illustrates a paradigm shift as well as other examples of normal science. You should be able to recognize paradigm shifts in your own fields as well.
- Understand the nature of science as a systematic process for acquiring knowledge about the physical world on the basis of evidence acquired through direct or indirect observation.
- Explain the scientific meaning of the word “theory”.
- Understand how in science we systematically identify and manage bias and error in science (confirmation bias, peer review, replication of research, community of science, controlled experiments).
- Explain how models are used to describe scientific phenomena; Have an appreciation of what makes a model good or bad (good input data, and proper assumptions) and how they improve over time; Respect the importance of models in science.
- Critically read an article in the popular media dealing with a scientific topic, assessing the claims made, the credibility of sources, and determine whether the claims are legitimate.

Module 1: The Nature of Science

Dates: Wed, August 27 – Mon, September 22

Session	Reading & Class Topic	Assignment Due
1.1 (8/27)	Course Introduction	
1.2 (9/3)	<i>Science Matters</i> : Introduction <i>Science Matters</i> : Ch 1 Knowing <i>Science for All Americans</i>	<i>Reading Quiz (1.2)</i>
1.3 (9/8)	<i>Vaccine Wars Research</i>	List of References <i>Sign up for free edu Prezi account</i>
1.4 (9/10)	<i>Social Structure of Science</i>	Vaccine War Presentation
1.5 (9/15)	<i>Structure of Scientific Revolutions</i>	<i>Reading Quiz (1.4-5)</i>
1.6 (9/17)	<i>Process of Scientific Advancement</i>	
1.7 (9/22)	<i>Theory of Plate Tectonics</i> <i>Science Matters</i> : Ch 13 Restless Earth	<i>Reading Quiz (1.6-7)</i> Module 1 Assignment

Exam 1: Wed, September 24 from 8:00am-9:00am



Module 2: Learning Outcomes & Schedule

By the end of Module 2, you will be able to:

- Explain the concepts energy density, energy content, and power.
- Explain and differentiate the concepts energy transformation, energy transport, and energy transfer.
- Explain the ramifications of the first and second Laws of Thermodynamics for energy processes.
- Discuss some of the problems with various energy sources, particularly non-renewable, and some of the benefits and drawbacks to alternative energy sources as well.
- Understand societal issues concerning energy (i.e. environmental, economic, political impacts).

Module 2: Energy

Dates: Wed, September 26 – Mon, October 20

Session	Reading & Class Topic	Assignment Due
2.1 (9/24)	Module 2 Introduction	
2.2 (9/29)	<i>Categorization of Energy</i> <i>Science Matters: Ch 2 Energy</i>	
2.3 (10/1)	<i>Physics for FP: Section II Introduction</i> <i>Physics for FP: Ch 5 Energy Surprises</i> <i>First & Second Laws</i>	<i>Reading Quiz (2.2-3)</i>
2.4 (10/6)	<i>Science Matters: Ch 3 Electricity & Magnetism</i> <i>Science Matters: Ch 4 The Atom</i>	Build an Atom worksheet
2.5 (10/8)	<i>Science Matters: Ch 8 Nuclear Physics</i> <i>Physics for FP: Ch 9 Radioactive Decay</i> <i>Physics for FP: Ch 12 Nuclear Power</i> <i>Physics for FP: Ch 14 Controlled Fusion</i>	<i>Reading Quiz (2.4-5)</i>
2.6 (10/13)	<i>Physics for FP: Ch 6 Solar Power</i> <i>Physics for FP: Ch 7 End of Oil</i> <i>Annual Energy Outlook 2013: Executive Summary</i>	
2.7 (10/20)	<i>Physics for FP: Ch 23 Non Solutions</i> <i>Physics for FP: Ch 24 Fruit on the Ground</i> <i>Physics for FP: Ch 25 New Technologies</i>	<i>Reading Quiz (2.6-7)</i> Energy Solutions Case Study

Exam 2: Wed, October 22 from 8:00am-9:00am



Module 3: Learning Outcomes & Schedule

By the end of Module 3, you will be able to:

- Articulate a biblical mandate for environmental stewardship.
- Explain the importance of biodiversity in ecosystems, as well as tangible human benefits from biodiversity. Explain how human activity has a negative impact on biodiversity.
- Understand the greenhouse effect and the contribution of various forcing factors and consequence for the earth's energy budget. Explain the consequences of increased greenhouse gases on the earth due to burning fossil fuels.
- Understand the role of the oceans as a CO₂ buffer, and the resulting acidification effect that is distinct from the global warming effect.
- Understand that the scientific models and the consensus of climate scientists today indicate a warming planet and that human activity is contributing to this.
- Intelligently discuss the implications for society in reference to climate change: what "mitigation" and "adaptation" mean, for example.
- Understand the basics of genetic modification and be able to defend both the use of them and the concerns related to their use.
- Indicate some of the complex issues that arise when practicing environmental stewardship in a multicultural world.

Module 3: Environmental Stewardship

Dates: Wed, October 22 – Wed, November 12

Session	Reading & Class Topic	Assignment Due
3.1 (10/22)	Module 3 Introduction	
3.2 (10/27)	<i>Science Matters</i> : Ch 14 Earth Cycles <i>Physics for FP</i> : Ch 9 A Brief History of Climate <i>Physics for FP</i> : Ch 20 The Greenhouse Effect	<i>Reading Quiz (3.2)</i>
3.3 (10/29)	<i>Loving the Least of These</i>	Reading Response
3.4 (11/3)	Climate Region Research	Climate Change Presentation
3.5 (11/5)	<i>Physics for FP</i> : Ch 21 A Very Likely Cause <i>Physics for FP</i> : Ch 22 Evidence	<i>Reading Quiz (3.5)</i>
3.6 (11/10)	<i>IPCC FAQ</i> : What factors determine the earth's climate? <i>IPCC FAQ</i> : How do Human Activities Contribute? <i>IPCC FAQ</i> : How Reliable are the Models	Module 2-3 Assignment
3.7 (11/12)	<i>Science Matters</i> : Ch 9 Ecosystems <i>Marine Conservation Summary Report</i>	<i>Reading Quiz (3.6-7)</i>

Exam 3: Mon, November 17 from 8:00am-9:00am



Module 4: Learning Outcomes & Schedule

By the end of Module 4, you will be able to:

- Explain some of the ways Christians in the sciences believe their doing science enhances your faith.
- Explain the essential scientific claims of the theory of evolution, distinguishing these claims from philosophical ones; how does the age of the earth relate to evolution?
- Explain why most scientists believe evolution is the best explanation of the development of the variety of living creatures we observe.
- Talk about different ways Christians deal with biblical passages in light of modern scientific discoveries.
- Understand the influence of biotechnology on their lives through dissecting a specific example (Personalized medicine, biotechnology industry), develop a consistently Christian Ethic on this issue. weave together scientific understanding and their faith to yield a well-grounded opinion about biotechnological issues.

Module 4: Science & Faith

Dates: Mon, November 17 – Wed, December 10

Session	Reading & Class Topic	Assignment Due
4.1 (11/17)	Module 4 Introduction	
4.2 (11/19)	<i>Science Matters</i> : Ch 16 The Code of Life <i>Language of God</i> : Ch 5 Deciphering God's Instruction Book	
4.3 (11/24)	<i>Science Matters</i> : Ch 17 Biotechnology <i>Language of God</i> : Appendix	<i>Reading Quiz (4.2-3)</i>
4.4 (12/1)	<i>Language of God</i> : Ch 1 From Atheism to Belief	Gene Therapy Presentation
4.5 (12/3)	<i>How are the ages of the Earth & universe calculated?</i> <i>Language of God</i> : Ch 3 Origins of the Universe Watch Dr. Phillip's Online Lecture	<i>Reading Quiz (4.4-5)</i>
4.6 (12/8)	<i>Language of God</i> : Ch 4 Life on Earth <i>Language of God</i> : Ch 6 Genesis, Galileo, Darwin <i>Language of God</i> : Ch 7 Atheism & Agnosticism	Module 4 Assignment Intro
4.7 (12/10)	<i>Language of God</i> : Ch 8 Creationism <i>Language of God</i> : Ch 9 Intelligent Design <i>Language of God</i> : Ch 10 Biologos	Module 4 Assignment <i>Reading Quiz (4.6-7)</i>

Exam 4 & Cumulative Final Exam: Mon, December 8 from 12:00pm - 2:00pm