

PROV301 (formerly UNIV301): GREAT IDEAS IN SCIENCE

Prof. Robert M. Hazen

Spring Semester, 2017

Mondays 4:30-7:10 pm; Enterprise 80

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Course Objective: The discoveries of science, as well as their technological applications, play major roles in your life—roles that impact your family, your health, your job, and much more. It is vital that every citizen understand the nature of science, and how scientists arrive at conclusions regarding health, safety, and the environment. The central objective of this course is to introduce to you the most important principles of science, with an emphasis on understanding science at a level that will allow you to appreciate varied natural phenomena in your daily life, as well as reports in magazines and newspapers. We avoid complex vocabulary and mathematics, while emphasizing a few core principles, as well as the nature of scientific questions, the importance of scientific facts, and the process of scientific discovery as a way of knowing.

This course, an integral part of the General Education program, has been designed to empower each of you with the ability to continue learning about science throughout your lifetime and to integrate scientific ideas into other aspects of your life. Scientific principles affect all of us, all the time. You don't have to be a scientist to appreciate the profound importance of science in everyday life and to be a part of the never-ending adventure of scientific discovery.

Course Texts (two copies of each will be on reserve at Johnson Center):

1. James Trefil and Robert Hazen, *The Sciences: An Integrated Approach*, 8th Edition. NY: Wiley, 2015.
2. Robert Hazen and James Trefil, *Great Ideas of Science: A Reader in the Classic Literature of Science*. San Diego: University Readers, 2009.

Important Dates:

Monday, January 23 – First day of class

Monday, February 13 – First Exam

Monday, March 6 – Second Exam; Last day to get 10 point bonus on museums

Monday, March 13 – Spring Break; NO CLASS

Monday, April 3 – Third Exam

Monday, April 24 – Fourth Exam; Last day to turn in museum visits and field trip forms

Monday, May 1 – Last class; last day to turn in lecture forms; final exam review

Monday, May 15 – Final Exam [No early final exams will be given]

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HONOR CODE – All assignments and exams must be done on your own. All students at GMU are governed by the provisions of the honor code, as given in the catalog. We take the honor code VERY SERIOUSLY and any violations will be reported.

LECTURE SCHEDULE, READING, AND VIDEOTAPES

The following schedule is subject to minor changes. Reading refers to chapters and pages in *The Sciences: An Integrated Approach (8th Edition)* and *Great Ideas Reader*. Reading is most effective if completed before class. You may wish to study by looking at the “Review” and “Discussion” questions at the end of chapters. I will not use the “Mathematical Problems,” nor will I cover the mathematical examples in the text – you may skip those sections.

Updated PowerPoints of all class lectures will be posted on Blackboard. Feel free to download them and follow along in class.

All of my lectures have been videotaped and audiotaped in 60 half-hour segments by The Teaching Company under the course name “The Joy of Science.” These lecture tapes are available on reserve in the Johnson Center (4-hour reserve for the videotapes and 24-hour reserve for the audiotapes), or for purchase from The Teaching Company. I have noted the lecture numbers for each week. If you have to miss a class session, please watch the videos or listen to the audiotapes for that week.

PART I: Forces, Motion, and Energy

We experience the world around us through the intertwined phenomena of forces, motions, and energy. The first four lectures of the course examine the historical discoveries and everyday implications of these fundamental ideas that connect all of the sciences.

1. Science as a Way of Knowing and the Ordered Universe (January 23, 2017)

Reading: *The Sciences*: Preface (pp.iii-ix); Chapter 1 “Science: A Way of Knowing (pp.1-21); Chapter 2 “The Ordered Universe” (pp.25-38; but you may skip the mathematical examples on pages 34 and 37). *Great Ideas Reader*: Chapter 1, John Snow.

“Joy of Science” Videotapes: Lectures 1-3

2. Isaac Newton's Laws of Motion and Gravity (January 30, 2017)

Reading: *The Sciences*, Chapter 2 (pp.38-48, but you can skip mathematical examples on pages 40, 42, and 46); *Great Ideas Reader*: Chapter 2, Newton.

“Joy of Science” Videotapes: Lectures 4-6

3. Work, Energy, and the Laws of Thermodynamics (February 6, 2017)

Reading: *The Sciences*, Chapter 3 “Energy” (pp.51-72); Chapter 4 “Heat and the Second Law” (pp.77-94), but you may skip the mathematical examples. *Great Ideas Reader*: Chapter 3, Benjamin Thompson.

“Joy of Science” Videotapes: Lectures 7-10

4. Electricity and Magnetism; Electromagnetic Radiation (February 13, 2017—EXAM #1)

Reading: *The Sciences*, Chapter 5 “Electricity and Magnetism” (pp.98-119); Chapter 6 “Waves and Electromagnetic Radiation” (pp.123-146), but you may skip the mathematical examples. *Great Ideas Reader*: Chapter 5, two letters by Benjamin Franklin; Chapter 6, Hertz.

“Joy of Science” Videotapes: Lectures 11-15

PART II: Matter

Every object in our material world is made of atoms. In Part II of the course, we explore the physical nature of atoms, their chemical bonds, and the properties of the solids, liquids, and gases around us. We'll also take a quick look at nuclear physics.

5. The Atom and Chemical Bonds (February 20, 2017)

Reading: *The Sciences*, Chapter 8 “The Atom” (pp.171-188); Chapter 9 “Quantum Mechanics” (pp.192-196 top); Chapter 10 “Atoms in Combination” (pp.208-217). *Great Ideas Reader*: Chapter 8, Mendeleev.

“Joy of Science” Videotapes: Lectures 17-18 and 20-21

6. Chemical Reactions and Material Properties (February 27, 2017)

Reading: *The Sciences*, Chapter 10 “Atoms in Combination” (pp.217-236); Chapter 11 “Properties of Materials” (pp.240-258). *Great Ideas Reader*: Chapter 11, Hazen.

“Joy of Science” Videotapes: Lectures 23-26

PART III: Earth and Space Sciences

The universe is littered with billions of galaxies, each holding billions of stars. Many of those stars feature planetary systems, perhaps with Earth-like planets. Part III focuses on the origin and characteristics of these celestial objects. We'll also look at Earth's origin, structure, and geological history.

7. Nuclear Physics: Radioactivity and Society (March 6, 2017—Exam #2; Last day for bonus)

Reading: *The Sciences*, Chapter 12 “The Nucleus of the Atom” (pp.263-283); Chapter 13 “The Ultimate Structure of Matter” (pp.287-297). *Great Ideas Reader*: Chapter 13, Collins.

“Joy of Science” Videotapes: Lectures 27-28

8. Stars and Galaxies (March 20, 2017)

Reading: *The Sciences*, Chapter 14 “The Stars” (pp.306-324); Chapter 15 “Cosmology” (pp.328-347). *Great Ideas Reader*: Chapter 15, Hubble.

“Joy of Science” Videotapes: Lectures 29-32

9. Earth and Other Planets; Plate Tectonics (March 27, 2017)

Reading: *The Sciences*, Chapter 16 “The Earth and Other Planets” (pp.350-372); Chapter 17 “Plate Tectonics” (pp.376-397); Chapter 18 “Cycles of the Earth” (pp.400-424). *Great Ideas Reader*: Chapter 17, Heezen et al.

“Joy of Science” Videotapes: Lectures 34-42 (Lots of lectures!)

PART IV: LIVING SYSTEMS

Life is the most complex system that we know in the universe. In Part IV, the last 5 weeks of the course, we'll focus on characteristics and behaviors that unite all living things on Earth. We'll find that a few overarching ideas unify all of biology.

10. The Life Sciences (April 3, 2017 – Exam #3)

Reading: *The Sciences*, Chapter 20 “Strategies of Life” (pp.449-470); Chapter 22 “Molecules of Life” (pp.494-511). *Great Ideas Reader*: Chapter 22, Wöhler.

“Joy of Science” Videotapes: Lectures 43-46

11. The Living Cell and Classical Genetics (April 10, 2017)

Reading: *The Sciences*, Chapter 21 “The Living Cell” (pp.474-491); Chapter 23 “Classical and Modern Genetics” (pp.514-533). *Great Ideas Reader*: Chapter 23, Mendel.
“Joy of Science” Videotapes: Lectures 47-49

12. Molecular Genetics and Biotechnology (April 17, 2017)

Reading: *The Sciences*, Chapter 23 “Classical and Modern Genetics” (pp.510-521); Chapter 24 “The New Science of Life” (pp.537-555). *Great Ideas Reader*: Chapter 23, Watson and Crick.

“Joy of Science” Videotapes: Lectures 50-53

13. Evolution (April 24, 2017 – All Museum/Field Trip Forms Due; Exam #4)

Reading: *The Sciences*, Chapter 25 “Evolution” (pp.559-582). *Great Ideas Reader*: Chapter 25, Darwin.

“Joy of Science” Videotapes: Lectures 54-57

14. The Environment and Final Exam Review (May 1, 2017; All seminar forms due)

Reading: *The Sciences*, Chapter 19 “Ecology, Ecosystems, and the Environment” (pp.427-446)

“Joy of Science” Videotapes: Lectures 58-60

Final Exam (Monday, May 15, 2017 at 4:30 pm in Enterprise 80)

Please note that there are no early final exams given. You must be present for the final exam on May 15th.

YOUR RESPONSIBILITIES – READ THIS CAREFULLY

All students should attend class, complete the readings, and be prepared to participate in class discussions. If, because of an emergency or illness, you must miss one of the four scheduled exams, **YOU MUST LET ME KNOW BEFORE THE CLASS BEGINS OR YOU WILL GET A ZERO ON THAT EXAM.** Call my office number (703-993-2163) or send an e-mail (rhazen@ciw.edu). **NO EXCEPTIONS!** If you do contact me in advance about a legitimate reason for missing an exam, I will arrange for a (more difficult) make-up exam. All make-up exams must be taken before the next class period.

Note also that because the unannounced i-clicker questions and quizzes are given in part to encourage attendance, you cannot make up missed i-clicker points under any circumstances.

GRADING POLICY – READ THIS CAREFULLY

Your grade will be based entirely on your point total:

850 or more	= A	800-849	= A-
760-799	= B+	720-759	= B
680-719	= B-	640-679	= C+
610-639	= C	580-609	= C-
500-579	= D	below 500	= F

Points can be earned in many ways, including:

Four in-class exams, of which the best 3 scores count	300 pts
Final Exam (May 15, 2017 at 4:30 pm)	300 pts
I-clicker quizzes (several each class; 25 pts maximum each class)	250 pts (maximum)
Lectures (up to 3 at 15 points each)	45 pts
Special point opportunities (limited time; announced in class)	40 pts
Museums and field trips (up to 3 at 20 pts each, with 10-point bonus)	70 pts
<hr/> Total possible points	<hr/> 1,005 pts

Your grades will be posted on Blackboard weekly. **It is your responsibility to check and confirm your point totals regularly throughout the semester.** [We will be posting thousands of separate grades this semester, and mistakes can happen!] You can accumulate points from any of these options. If you choose not to go to a museum or if you miss an exam or i-clicker question, that is your decision. Your grade depends only on the point total at the end of the semester. Here are a few details on the options.

Four In-Class Exams: The four announced 1-hour exams are worth 100 points each. Your top 3 scores will count, for a maximum of 300 points. Most students finish these exams in 20 minutes or less. Questions will be multiple choice with 20 questions (5 points each) based on classroom lectures and reading. You will need a Scantron card and #2 pencil for each exam. I will distribute study notes or provide sample questions the week prior to each of these four exams. See also Blackboard for exam study guides. In emergency situations – if you are sick, or have a documented emergency – **you must notify me before the class or you will get a zero for the exam.** If you do miss an exam and notify me in time, you will have until the next class to do a (more difficult) make-up. **No make-up exams will be accepted after the next class begins.**

Final Exam (Monday, May 15, 2017): More details later, but it takes most students less than 1 hour, though 2 hours will be allowed. Typically, 60 multiple-choice questions (5-points each) will be based on the scientific principles discussed in class and in the readings, not simply on memorized facts. You will need a Scantron card and a #2 pencil. A study guide with more details will be distributed at the last class period and posted on Blackboard. A total of 300 points is possible on the final.

I-clicker Pop Quizzes and Questions: “I-Clicker” is an interactive tool that allows us to ask questions, give pop quizzes, and conduct surveys during the class period, and to evaluate your answers (and post your grades) in real time. Many of you will have used it before, but some will not. It’s really easy.

Briefly, here’s how it works: You need to purchase a personalized I-clicker, which is a small hand-held electronic device (they will be sold at the GMU computer store, and you can get them online, new or used, as well). You should also be sure to have spare batteries. You must bring this small transmitting unit to every class, including exam days. From time to time during the class you will be given a multiple choice question, and you will have 45 seconds to respond with an answer by pushing a button on your unit. I will have a master receiving unit that collects all the answers, graphs the distribution of answers, grades your answer, and records the scores on Blackboard.

We plan to give several questions each class. Some will be in the nature of a survey and you will get points (usually 3 points) just for answering the question. Other questions will be based on the lecture material and will be graded (usually 5 points for a correct answer and 1 point for an incorrect answer).

We freely admit that this is an attempt to encourage class attendance and alertness. We will probably give more than 60 questions through the course of the semester for a maximum of more than 250 points, but we will only count 250 points. That way you shouldn’t feel too stressed if you miss one class during the semester.

Please note that these questions might be given at any time during a lecture, including exam nights, and there will always be several questions each evening. It is never possible to make up I-clicker questions. If you miss part of the class for any reason, or if you forget your I-clicker unit, or if the battery is dead, or if you fall asleep, the points cannot be made up.

One more point. For obvious reasons you can only bring one I-clicker to class. We have had serious problems with I-clicker cheating in the past and we take such honor code violations very seriously. There are simple ways to check if someone is using more than one I-clicker unit. If we see anyone with two I-clickers **you and the second person will receive zero for the entire semester’s i-clicker score (a loss of up to 250 points) and the violation will be reported to the Honor Board.**

Museum Visits and Field Trips (Last day to turn in this assignment is April 24th, no exceptions): Many museum exhibits underscore the great ideas of science. Accordingly, during the semester you can get 20 points each for visits to three different science museums or sites of scientific interest, for a total of 60 points. For each site you must fill out a “Museum Visit Form” (see below or Blackboard for the form) that includes your name, a photo of you at the site, and a statement of how a specific exhibit or display illustrates some aspect of one of the following great ideas of science. The three museum exhibits or sites you choose must illustrate three different of these great ideas of science.

1. Newton’s laws describe motions on Earth and in space.
2. Energy can change from one form to another.

3. Electricity and magnetism are two aspects of the same force.
4. Material properties result from their atoms and how those atoms are bonded.
5. Earth's surface is constantly changing.
6. Ecosystems are interdependent communities of living things.
7. All living things are made of cells.
8. All living things use the same genetic code.
9. Life on Earth has changed over time – the process of evolution.

Among the dozens of possible nearby museums and other sites are:

National Museum of Natural History (Smithsonian, exhibits or IMAX theaters)
 National Air and Space Museum (exhibits in DC or the Dulles Annex, or IMAX)
 National Geographic Explorers Hall
 National Zoo
 United States Botanic Garden
 Baltimore Aquarium
 American Museum of Natural History in New York (can be used for 2 “visits”)
 Sideling Hill, Maryland
 Luray Caverns, Virginia

So, for example, a visit to the United States Botanic Garden might lead you to an exhibit that illustrates how ecosystems are interdependent communities of living things. Be creative, and don't hesitate to ask us if you're on the right track.

We require that you submit a photograph of yourself at each site. If the museum prohibits photographs, then you must submit an alternate proof, such as a receipt from the museum store or IMAX theater. Note that because of the large number of students and size of electronic images **we do not accept electronic forms**. All assignments must be submitted in hard copy. This is one assignment, so turn in all of your forms AT THE SAME TIME. And if you turn in your three museum forms on or before **March 6th**, you will receive an extra 10 points!

Scientific Lectures, Seminars or Other Presentations: (Last day to turn in this assignment is May 1st, no exceptions): You can get 15 points each for attendance at up to three different science lectures or seminars, on or off campus (for a total of up to 45 points). We'll announce many qualifying lectures during the semester. Most of these opportunities will be e-mailed to the class and posted on Blackboard. However, it is your responsibility to find and attend approved lectures or seminars. Please let us know if you know of a special event going on and we'll notify the class. Additional opportunities need to be approved, so please obtain PRIOR approval. You should hand in a completed “Scientific Lecture, Seminar, and Presentation” form. This form is printed below, and it can also be found on Blackboard. For each lecture, hand in the form with the title of the lecture, the speaker's name, and a statement (one sentence) about one interesting fact or idea that you learned. You **MUST** turn in your lecture or seminar documentation at class **no more than two weeks following the lecture**. (So if you attend a seminar on a Thursday night, your documentation is due on or before the class following the next Monday.) The last day to turn in lecture/seminar documentation is **May 1st**. Any documentation that does not include a signed attendance/courtesy statement will receive no points.

SPECIAL NOTICE: If you have registered early for PROV301, you may complete one or more of your museum visits and science lectures before the beginning of the semester. January is a great time to visit science museums in downtown DC or in your home area. You can hand in these assignments as early as the first day of class.

Museum Visit & Field Trip Form

Your Name: _____

Date of Attendance: _____

Name of Museum or Site Visited: _____

Name of Exhibit or Display: _____

What "Great Idea" of Science was Illustrated?

How was the "Great Idea" illustrated? _____

Attach your photo at the museum or site here:

NOTE: This is one assignment. Turn in all three museum forms
(or as many as you are going to submit) at the same time on or before April 24, 2017.
If you turn in your three museum forms on or before March 6th you will receive 10 extra points.

Scientific Lecture, Seminar, and Presentation Attendance Form

Your Name: _____

Date of Attendance: _____

Title of Lecture, Seminar, or Presentation: _____

Speaker(s): _____

Location of Event: _____

Hypothesis (what was tested):

Key Concepts/Outcomes:

One thing you learned /something interesting: _____

Attendance/Courtesy Statement: I certify that I attended this lecture, was courteous* to the speaker(s) and attendees, and remained for (circle one) A) the entire program; or B) _____ minutes of the program.

Your Signature _____

*Courtesy is defined as showing up on time, being quiet while speakers are talking, not disruptive to others (includes entering/exiting), and leaving only after a speaker is done speaking.

NOTE: These are separate assignments. Hand in each lecture form on one of the two Mondays following the lecture. Late forms will not count. All forms must be handed in on or before May 1st, 2017.