

Natural Sciences 1: Laws and Models in Chemistry

Fall 2011, Weekday Program

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“Historical and logical methods are used to understand and analyze the atomic theory of matter. The basic question of the course is: What is the world made of? Scientific models which purport to answer this question have historically been classified under the science of chemistry. Hence, Natural Sciences 1 is a chemistry course that begins with the Ancient Greek philosophers and continues into the early twentieth century. It starts with the idea that matter is composed of Thales’ one element or Empedocles’ four elements, and ends with Mendeleev’s periodic table of some ninety-odd elements ordered in terms of weight. The course focuses upon several key concepts, such as weight, structure, and complexity, in an attempt to understand the material basis of the world.”¹

The expectations for this course are as follows:

Participation (40%): This is the way you will come to an understanding of the readings, which you are expected to do carefully before class on the specified day. In order to participate fully, you need to come to class on time every day. Every missed class, late arrival, early departure, and break counts against your participation grade. If you miss more than four class sessions, you will not pass the course, except in unusual circumstances. I’ll warn you after two absences.

Written Work (60%): You may discuss all assignments with your classmates, but must do your own writing. This means that you may neither look at another student’s written work nor share your written work with others. All written work is due in hard copy at the beginning of class. If you are unable to turn in an assignment on time, speak with me in advance. Late work without an extension will receive a lower grade than it normally would. If an assignment is complete by the due date, you may revise it, provided you speak with me within one week of receiving your work back to arrange a new due date. **No work will be accepted after 4 pm on Friday, December 2.**

Focus statements (10%): At the beginning of each class, one student will present a short written statement that focuses the reading assignment. More details are given at the end of the syllabus.

Essay & Lab Work (15% each): You must write an essay of 4–6 pages on a system of natural philosophy of your own creation that explains what changes and what remains the same when we observe change in the physical world. In it, you will describe a world view in which you balance two issues: if we observe change in the world around us, why isn’t the world chaotic, and if the world is orderly and consistent, why isn’t it rigid and unchanging? You are expected to cite your sources correctly; see *Writing with Sources* or talk to me if you do not know how. Plagiarism will be strictly penalized. You must also keep a lab notebook and write a lab report on one of the experiments we perform in class. Details of how to do this will be covered when we start doing labs.

Problems & Final Exam (20%): Occasional homework problems (5%) will be assigned and a final exam (15%) will be due at the end of the semester. Part of the final will be in-class and part take-home.

¹“Natural Sciences Courses.” *Shimer College*. Shimer College, n.d. Web. 12 August 2011.

Learning Objectives

1. Explain Aristotle’s classification of causes and identify how they relate to modern scientific thinking.
2. Carry out a written scientific procedure and write a lab report.
3. Balance the notions of change and constancy in a description of the world.
4. Describe the basic behavior of gasses, especially the relation between mass, temperature, pressure, and volume.
5. Explain the atomic model of matter and describe experiments that support that model.
6. Define “heat” and describe experiment(s) based on that definition.
7. Explain what a chemical equation means.

Booklist

- Bacon, Francis. *The New Organon*. Ed. Fulton H. Anderson. Upper Saddle River, NJ: Prentice-Hall, 1960. Print.
- Lucretius. *On the Nature of the Universe*. Trans. R. E. Latham. Revised ed. London: Penguin, 2005. Print.
- Sachs, Joe. *Aristotle’s Physics: A Guided Study*. New Brunswick: Rutgers UP, 2008. Print.
- Shamos, Morris H., ed. *Great Experiments in Physics: Firsthand Accounts from Galileo to Einstein*. Mineola, NY: Dover, 1959. Print.
- Shimer College. *Natural Sciences One*. 2 vols. Chicago: Dinosaur Press, 2010. Print.
- Wheelwright, Philip, ed. *The Presocratics*. Upper Saddle River, NJ: Prentice-Hall, 1997. Print.

Calendar

The Nature of Matter & Scientific Knowledge	
Aug. 25	<i>Presocratics</i> , p. 31–63
M29	<i>Presocratics</i> , p. 64–89
W31	<i>Presocratics</i> , p. 90–119
Sept. 1	<i>Presocratics</i> , p. 120–136, 143–154
W7	<i>Presocratics</i> , p. 200–229
R8	Lucretius, <i>On the Nature of the Universe</i> , Book 1
M12	Lucretius, <i>On the Nature of the Universe</i> , Book 2
W14	Aristotle, <i>Physics</i> , Book 2, Chapters 1–9
R15	Aristotle, <i>Physics</i> , Book 3, Chapters 1–3 & Book 4, Chapters 1–5
M19	Aristotle, <i>Physics</i> , Book 4, Chapters 6–9
W21	Bacon, <i>The New Organon</i> , Book 2, Aphorisms 1–13
R22	Bacon, <i>The New Organon</i> , Book 2, Aphorisms 14–22
PAPER DUE	

The Nature of Air & Fire	
M26	Pascal, "New Experiments Concerning the Vacuum," p. 355–371 Pascal, "Account of the Great Experiment," p. 372–389
W28	Pascal, "Treatise on the Equilibrium of Liquids," p. 390–403 LAB: 32-foot column of water
R29	Pascal, "Treatise on the Weight and Mass of the Air," p. 403–429
Oct. 3	Boyle, "Boyle's Law" in Shamos, p. 36–41 LAB: Boyle's law
W5	Du Chatelet, <i>On Fire</i> , Book 1
M10	Stahl, "On Sulphur" Macquer, <i>A Dictionary of Chemistry</i> Macquer, <i>Elements of the Theory and Practice of Chemistry</i>
W12	Priestley, <i>On Dephlogisticated Air</i> , p. 5–55 LAB: Dephlogistication of magnesium
R13	Lavoisier, <i>Memoir on the Calcination of Tin</i> , p. 155–160 LAB: 'Calcination' of iron
M17	Lavoisier, <i>Elements of Chemistry</i>
The Nature of Heat & Energy	
W19	Black, <i>Lectures on the Elements of Chemistry</i> LAB: Latent heat and/or supercooling
R20	Thompson, "An Inquiry Concerning the Source of the Heat..."
M24	Leibniz, "A Brief Demonstration of a Notable Error..." Du Chatelet, "Of the Force of Bodies"
W26	Joule, "The Mechanical Equivalent of Heat" Shamos, p. 166–183 LAB: Mechanical equivalent of heat
The Atomic Theory of Matter	
R27	Dalton, "Theory of the Absorption of Gases" Letters from Bostock & Dalton to Nicholson Dalton, 1808 Extract LAB REPORT DUE
M31	Gay-Lussac, "On the Combination of Gaseous Substances" Dalton, 1810 Extract
Nov. 2	Avogadro, "Essay on a Manner of Determining the Relative Masses..."
R3	Dulong, "Atomic Weights and Specific Heat"
M7	Clausius, "On the Nature of the Motion that We Call Heat" §1–9
W9	Clausius, "On the Nature of the Motion that We Call Heat" §10–15
R10	Berzelius, "Electrochemical Theory" Faraday, "On Electrochemical Decomposition" LAB: Electrochemical voltages
M14	Berzelius, "Chemical Symbols and Formulas"
W16	Canizzaro, <i>Sketch of a Course of Chemical Philosophy</i> , p. 1–18
R17	Canizzaro, <i>Sketch of a Course of Chemical Philosophy</i> , p. 19–34

M21	Meyer, "The Nature of the Chemical Elements..." Mendeleev, "A Natural System of the Elements..."
M28	The Periodic Table LAB: Observe element sample
W30	Curie, "Radium and the New Concepts in Chemistry"
Dec. 1	In-class part of the final
F2	FINAL EXAM DUE AT 4 PM

Focus statements

A focus statement is a 1-2 page paper based on the assigned reading and intended for class discussion. It might take the form of a summary of the reading, a close analysis of a particular passage, a personal but textually and argumentatively supported reaction to a reading, an extended question or series of questions raised by the text, or a concise formal essay in which a thesis from or about a text is supported and discussed.

One possible approach is to use a point made by an author in a reading as your thesis (after considering whether it can be adequately discussed in a focus statement or essay of the prescribed length). Quote, paraphrase, and/or summarize passages from the text (citing them appropriately, including page numbers!) where the point you have chosen is being stated, where it is being argued, and, if appropriate, where it is being clarified or qualified. Add whatever clarifications and interpretations of your own you consider helpful. You may need to provide definitions of key terms, in the author's words if possible. Offering examples, the author's or your own, is almost always a good idea.

After you have presented and explained the author's point and argument, go on to your own response to it. Your response should be thought through, carefully phrased, and persuasively supported with arguments and/or examples. Whether you agree or disagree, be sure to consider both sides. If you disagree, do not confine yourself to giving your reasons, but also try to show what you think are the blind spots or logical errors or gaps in the author's discourse. Agreement and disagreement are not the only possible reactions. You may want to qualify, expand upon, or significantly rephrase the author's point, to consider its implications, or point out its logical or social consequences. A good way to end a focus statement is with a thought-provoking question for the class.

Be careful not to lose focus. You can bring in other texts that support, reflect upon, or contradict the primary text, but remember that you are writing about a particular idea in a particular reading and you only have 1-2 pages.

If all else fails or you are thoroughly confused by the text, share your confusion and list your questions. These sometimes serve as the basis of great class discussions.

Focus statement dates will be assigned as we go. We will only have time to discuss one focus statement per class, so once a focus statement date is reserved, it is not available to others. In class, the focus statement is first read aloud by the writer and then discussed by the group. Be sure to bring enough copies of your statement for everyone. If timely submission of a focus statement and copies for distribution will not be possible, it is your responsibility to switch the assigned focus statement date with another member of the class.