ASU

ARIZONA STATE UNIVERSITY

GENERAL STUDIES COURSE PROPOSAL COVER FORM

Course information:

*Copy and paste **current** course information from [Class Search/Course Catalog](#).*

Academic Unit: **Mary Lou Fulton Teachers College**　　Department: **Division of Teacher Preparation**

Subject: **SCN**　　Number: **250**　　Title: Physical Science by Inquiry　　Units: 4

Is this a cross-listed course? No
If yes, please identify course(s)

Is this a shared course? No　　If so, list all academic units offering this course

Course description:
Laboratory-based development of concepts and reasoning skills in the physical sciences. Emphasizes open-ended investigations, dialogues between the instructor and individual students, and small group discussions. Helps students think of physical science as an active process of discovery in which they can participate. Helps preservice teachers understand inquiry and develop inquiry skills. Liberal arts students gain experience in the scientific process. Useful for students who wish to improve their science preparation before taking further science courses. Forms foundation for scientific literacy.

Requested designation: Natural Sciences-SQ

*Note- a **separate** proposal is required for each designation requested*

Eligibility:

Permanent numbered courses must have completed the university's review and approval process.
For the rules governing approval of omnibus courses, contact the General Studies Program Office at (480) 965-0739.

Area(s) proposed course will serve:

A single course may be proposed for more than one core or awareness area. A course may satisfy a core area requirement and more than one awareness area requirements concurrently, but may not satisfy requirements in two core areas simultaneously, even if approved for those areas. With departmental consent, an approved General Studies course may be counted toward both the General Studies requirement and the major program of study.

Checklists for general studies designations:

Complete and attach the appropriate checklist

- Literacy and Critical Inquiry core courses (L)
- Mathematics core courses (MA)
- Computer/statistics/quantitative applications core courses (CS)
- Humanities, Fine Arts and Design core courses (HU)
- Social and Behavioral Sciences core courses (SB)
- Natural Sciences core courses (SQ/SG)
- Global Awareness courses (G)
- Historical Awareness courses (H)
- Cultural Diversity in the United States courses (C)

A complete proposal should include:

☒ Signed General Studies Program Course Proposal Cover Form
☒ Criteria Checklist for the area
☒ Course Syllabus
☒ Table of Contents from the textbook, and/or lists of course materials

Contact information:

Name: David E. Meltzer　　Phone: 480-727-5215

Mail code: 2680　　E-mail: david.meltzer@asu.edu

Department Chair/Director approval: *(Required)*

Chair/Director name (Typed): Elizabeth R. Hinde　　Date: 3/10/14

Chair/Director (Signature): Elizabeth R. Hinde

Rev. 1/94, 4/95, 7/98, 4/00, 1/02, 10/08, 11/11/ 12/11, 7/12

Arizona State University

Rev. 1/94, 4/95, 7/98, 4/00, 1/02, 10/08, 11/11/ 12/11, 7/12

Arizona State University Criteria Checklist for

NATURAL SCIENCES [SQ/SG]

Rationale and Objectives

In a relatively short time in the history of civilized societies, humankind moved from what was essentially an agrarian population into an industrial age, which in recent years has been profoundly shaped by such scientific and technological advances as genetic engineering, the computer, and space exploration. Our history of irrepressible ingenuity makes a compelling case for a future that will be even more profoundly influenced by science and technology. It is imperative that we react expeditiously and effectively to the problems and the promise that these advances create. We must ensure that technological change is directed to the benefit of society and that it will promote human dignity and values. Success in achieving this goal will depend upon the insight and knowledge of political and public opinion leaders, and the scientific enlightenment of educated citizens. To a significant degree, the ability of these individuals to understand the nature of the issues and the alternative courses of action will be determined by the quality of science presented at the nation's institutions of higher learning.

The recommendation of at least one laboratory course that includes a substantial introduction to the fundamental behavior of matter and energy in physical or biological systems derives from a number of considerations. First, all physical and biological phenomena have at their roots the fundamental principles governing the behavior of matter and energy. These principles have been shown over a period of time to be a value in reliably predicting and rationalizing a broad range of phenomena. Unless the lines to these roots are established, our understanding of the broader range of the sciences, and other fields upon which these sciences impinge, will be impaired. Second, because these fundamental principles have been experimentally established beyond reasonable doubt, the essentials of the scientific method can be clearly and coherently revealed by their study. Third, the study of the behavior of matter and energy illustrates the usefulness of mathematics in precisely describing and rationalizing certain physical phenomena, and the expressiveness of mathematical equation.

10/1989
REV: 1/1991, 3/1991, 1/2000, 10/2008

Note: "Table of Contents" refers to the text *Physics by Inquiry;* it is attached at the end of this submission.

Proposer: Please complete the following sections and attach appropriate documentation.

ASU--[SQ] CRITERIA

I. - FOR ALL *QUANTITATIVE* [SQ] NATURAL SCIENCES CORE AREA COURSES, THE FOLLOWING ARE CRITICAL CRITERIA AND MUST BE MET:

YES	NO		Identify Documentation Submitted
☒	☐	**A.** Course emphasizes the mastery of basic scientific principles and concepts.	Course syllabus and course description
☒	☐	**B.** Addresses knowledge of scientific method.	Course syllabus and course description
☒	☐	**C.** Includes coverage of the methods of scientific inquiry that characterize the particular discipline.	Course syllabus and course description
☒	☐	**D.** Addresses potential for uncertainty in scientific inquiry.	Course syllabus and course description; Table of Contents, Volume 1, Properties of Matter, Section C
☒	☐	**E.** Illustrates the usefulness of mathematics in scientific description and reasoning.	Table of Contents: Volume I, Properties of Matter, Section C Volume II, Kinematics, Sections C and D
☒	☐	**F.** Includes **weekly** laboratory and/or field sessions that provide hands-on exposure to scientific phenomena and methodology in the discipline, and enhance the learning of course material.	Course syllabus and course description
☒	☐	**G.** Students submit written reports of laboratory experiments for constructive evaluation by the instructor.	Course syllabus and course description
☒	☐	**H.** Course is general or introductory in nature, ordinarily at lower-division level; not a course with great depth or specificity.	Course syllabus and course description

II. - AT LEAST ONE OF THE FOLLOWING ADDITIONAL CRITERIA MUST BE MET WITHIN THE CONTEXT OF THE COURSE:

☒	☐	**A.** Stresses understanding of the nature of basic scientific issues.	Course syllabus and course description
☒	☐	**B.** Develops appreciation of the scope and reality of limitations in scientific capabilities.	Course syllabus and course description
☐	☐	**C.** Discusses costs (time, human, financial) and risks of scientific inquiry.	
NOTE: CRITERIA FOR [SG] COURSES BEGIN ON PAGE 4.			

III. - [SQ] COURSES MUST ALSO MEET THESE ADDITIONAL CRITERIA:			
YES	**NO**		**Identify Documentation Submitted**
☒	☐	**A.** Provides a substantial, quantitative introduction to fundamental principles governing behavior of matter and energy, in physical or biological systems.	Course syllabus and course description
		B. Includes a college-level treatment of some of the following topics **(check all that apply below):**	
☒	☐	**a.** Atomic and molecular structure	Course syllabus and course description
☒	☐	**b.** Electrical processes	Course syllabus; textbook Table of contents Vol. II
☒	☐	**c.** Chemical processes	Course syllabus and course description
☒	☐	**d.** Elementary thermodynamics	Course syllabus; textbook Table of contents Vol. I
☒	☐	**e.** Electromagnetics	Course syllabus; textbook Table of contents Vol. II
☒	☐	**f.** Dynamics and mechanics	Course syllabus; textbook Table of contents Vol. II

[SQ] REQUIREMENTS CANNOT BE MET BY COURSES:

- **Presenting a qualitative survey of a discipline.**
- **Focusing on the impact of science on social, economic, or environmental issues.**
- **Focusing on a specific or limiting but in-depth theme suitable for upper-division majors.**

Proposer: Please complete the following section and attach appropriate documentation.

ASU--[SG] CRITERIA			
I. - FOR ALL *GENERAL* [SG] NATURAL SCIENCES CORE AREA COURSES, THE FOLLOWING ARE CRITICAL CRITERIA AND MUST BE MET:			
YES	**NO**		**Identify Documentation Submitted**
☐	☐	**1.** Course emphasizes the mastery of basic scientific principles and concepts.	
☐	☐	**2.** Addresses knowledge of scientific method.	
☐	☐	**3.** Includes coverage of the methods of scientific inquiry that characterize the particular discipline.	
☐	☐	**4.** Addresses potential for uncertainty in scientific inquiry.	
☐	☐	**5.** Illustrates the usefulness of mathematics in scientific description and reasoning.	
☐	☐	**6.** Includes **weekly** laboratory and/or field sessions that provide hands-on exposure to scientific phenomena and methodology in the discipline, and enhance the learning of course material.	
☐	☐	**7.** Students submit written reports of laboratory experiments for constructive evaluation by the instructor.	
☐	☐	**8.** Course is general or introductory in nature, ordinarily at lower-division level; not a course with great depth or specificity.	
II. - AT LEAST ONE OF THE ADDITIONAL CRITERIA THAT MUST BE MET WITHIN THE CONTEXT OF THE COURSE:			
☐	☐	**A.** Stresses understanding of the nature of basic scientific issues.	
☐	☐	**B.** Develops appreciation of the scope and reality of limitations in scientific capabilities.	
☐	☐	**C.** Discusses costs (time, human, financial) and risks of scientific inquiry.	

[SG] REQUIREMENTS CANNOT BE MET BY COURSES:		
	• Presenting a qualitative survey of a discipline.	
	• Focusing on the impact of science on social, economic, or environmental issues.	
	• Focusing on a specific or limiting but in-depth theme suitable for upper-division majors.	

Course Prefix	Number	Title	Designation
SCN	250	Physical Science by Inquiry	SQ

Explain in detail which student activities correspond to the specific designation criteria. Please use the following organizer to explain how the criteria are being met.

Criteria (from checksheet)	How course meets spirit (contextualize specific examples in next column)	Please provide detailed evidence of how course meets criteria (i.e., where in syllabus)
A. Course emphasizes the mastery of basic scientific principles and concepts.	The course is focused on mastering the fundamental principles of physical science including laws of motion, electricity and magnetism, and thermodynamics. Students will be able to analyze the behavior of physical systems using given information or using observations they make themselves, through reasoning on the basis of physical laws and principles. They will gain experience in representing and characterizing physical systems with mathematical descriptions as well as with diagrammatic methods and verbal descriptions. They will be able to respond to questions about a wide variety of physical systems, posed in a variety of representations and contexts. Through these means students will develop the ability to predict and control the behavior of diverse physical systems. It is	Course Syllabus: Catalog Description, Course Format, Course Activities and Philosophy, Course Goals (pp. 1-2); Course Calendar (pp. 3-4); Course Assignments (p. 4).

	important to point out that every class and every lab activity in this course is consistent with this criterion; therefore, no attempt is made (in Column 3) to focus on one or another specific activity.	
B. Addresses knowledge of scientific method.	Through the various course activities the students experience the scientific process at first hand, reproducing (albeit in a simplified and carefully guided context) the same activities carried out by real scientists in actual scientific investigations and at scientific conferences at which findings are presented. By observing physical systems, developing tentative models to predict and explain the behavior of those systems, and by designing and carrying out investigations to test those models, students will develop and deepen their knowledge of the scientific method. (Again, this property of experiencing first-hand the nature of the scientific process and method is characteristic of every set of activities within the syllabus, so no attempt is made to highlight any particular activity or activities. With the exception of Section III below, this same	Course Syllabus: Catalog Description, Course Format, Course Activities and Philosophy (pp. 1-2); Tentative Course Calendar (pp. 3-4); Course Assignments (p. 4)

	procedure is followed in the evidence provided in Column 3 for each of the remaining criteria.)	
C. Includes coverage of the methods of scientific inquiry that characterize the particular discipline.	Students will attempt to find relationships among the various controllable parameters of physical systems, and will develop mathematical and physical models to predict and explain those relationships. They will design and carry out controlled experiments in which their proposed models are tested by keeping unchanged all but one variable parameter, in order to explore the effects on the system of changing that parameter. This process of forming hypotheses and creating tentative models of physical behavior, and then testing those models by designing and carrying out controlled experiments, is repeated from one week to the next throughout the course. Students will explore the role of uncertainty in their findings by assessing the degree of certainty possible for predictions made from their model, in light of the uncertainties in their observations and their	Course Syllabus: Course Activities and Philosophy (pp. 1-2); Course Assignments (p. 4)

	measurements of physical quantities. The nature of uncertainty inherent in all scientific work will be a continuing theme throughout the course. There will be a continuing focus of discussion on the general principles underlying the methods of inquiry and the nature of uncertainty in scientific work, and students' attention will be directed toward applying these methods of investigation in other applicable circumstances, as well as recognizing their appearance in relevant news reports and other everyday encounters.	

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Criteria (from checksheet)	How course meets spirit (contextualize specific examples in next column)	Please provide detailed evidence of how course meets criteria (i.e., where in syllabus)
D. Addresses potential for uncertainty in scientific inquiry.	Treatment of experimental uncertainty and its implications are emphasized throughout the course starting from the very first day, but receives special emphasis in the initial investigations of mass, volume, and density measurements. In all further investigations, students are required to provide estimates of uncertainty and to qualify statements of conclusions of their findings with appropriate references to uncertainties.	Course Syllabus, p. 3, January 18-20 and January 25-27; Course textbook Volume 1, Properties of Matter, Part A (Measurement of Matter), §4, Uncertainty) , Part B (Pure Substances), §11(Measurements of densities)
E. Illustrates the usefulness of mathematics in scientific description and reasoning.	Mathematical representations (both graphical and algebraic) are utilized in every phase of the course, but receive special emphasis in the investigations of density, and of force and motion.	Utilization of graphical and algebraic representations of (a) density: Course Syllabus, p. 3, January 25-27; Course textbook Volume I, Properties of Matter, Part C (Scientific Representations); and (b) motion: Course Syllabus, p. 3, February 1-3, February 8-10; Course

		textbook Volume II, Kinematics, Part C (Graphical Representations of Motion), and Part D (Algebraic Representations of Motion).
F. Includes weekly laboratory and/or field sessions that provide hands-on exposure to scientific phenomena and methodology in the discipline, and enhance the learning of course material.	The entire course is based on hands-on laboratory investigations of physical systems and physical phenomena, all within the context of using scientific methodology to explore and understand physical phenomena and to learn the targeted physical concepts.	Course Syllabus: Catalog Description, Course Format, Course Activities and Philosophy (pp. 1-2); Tentative Course Calendar (pp. 3-4); Course Assignments (p. 4)

Course Prefix	Number	Title	Designation
SCN	250	Physical Science by Inquiry	SQ

Explain in detail which student activities correspond to the specific designation criteria.
Please use the following organizer to explain how the criteria are being met.

Criteria (from checksheet)	How course meets spirit (contextualize specific examples in next column)	Please provide detailed evidence of how course meets criteria (i.e., where in syllabus)
G. Students submit written reports of laboratory experiments for constructive evaluation by the instructor.	Students submit regular written reports of their group's investigations and findings, and grades on these reports are a significant component of the course grade. Grading will focus on thoroughness, attention to detail, clarity of expression, and use of careful reasoning in experimental methods and analysis of outcomes.	Course Syllabus: Course Activities and Philosophy (pp. 1-2); Course Assignments (p. 4).
H. Course is general or introductory in nature, ordinarily at lower-division level; not a course with great depth or specificity.	This is an introductory course that provides broad coverage of fundamental principles in physical science. General principles and interrelationships among those principles are emphasized, rather than specific details or accumulations of unrelated factual knowledge.	Course Syllabus: Catalog Description, Course Format, Course Activities and Philosophy (pp. 1-2); Tentative Course Calendar (pp. 3-4).
ADDITIONAL CRITERIA A. Stresses understanding of the nature of basic scientific issues.	Students experience the scientific process at first hand by reproducing (albeit in a simplified and carefully guided context) the same activities carried out by real scientists in actual scientific investigations	Course Syllabus: Catalog Description, Course Format, Course Activities and Philosophy (pp. 1-2); Course Assignments (p. 4).

	and at scientific meetings at which findings are presented. In this way, the course stresses the nature of basic scientific issues such as how to develop adequate representations of the physical world, methods for designing and implementing effective tests of those representations, and the challenge of effective communication of scientific results.	

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SCN	250	Physical Science by Inquiry	SQ

Explain in detail which student activities correspond to the specific designation criteria. Please use the following organizer to explain how the criteria are being met.

Criteria (from checksheet)	**How course meets spirit (contextualize specific examples in next column)**	**Please provide detailed evidence of how course meets criteria (i.e., where in syllabus)**
ADDITIONAL CRITERIA B. Develops appreciation of the scope and reality of limitations in scientific capabilities.	Through the course activities students will develop the ability to predict and control the behavior of diverse physical systems. However, an integral component of every investigation and discussion of experimental outcomes is a discussion of the uncertainties inherent in predicting and explaining outcomes of their experiments. Through repeated focus on this issue, students will develop some appreciation of the scope and reality of limitations in scientific capabilities.	Course Syllabus: Course Activities and Philosophy, Course Goals (pp. 1-2).
FURTHER ADDITIONAL CRITERIA A. Provides a substantial, quantitative introduction to fundamental principles governing behavior of matter and energy, in physical or biological systems.	The entire course is focused on quantitative formulations of the fundamental principles of interactions in physical systems, with energy transformation being the most common element among all the different topics (see B[a-f] below).	Course syllabus, Tentative Course Calendar, pp. 3-4

Course Prefix	**Number**	**Title**	**Designation**
SCN	250	Physical Science by Inquiry	SQ

Explain in detail which student activities correspond to the specific designation criteria. Please use the following organizer to explain how the criteria are being met.

Criteria (from checksheet)	**How course meets spirit (contextualize specific examples in next column)**	**Please provide detailed evidence of how course meets criteria (i.e., where in syllabus)**
FURTHER ADDITIONAL CRITERIA B. Includes a college-level treatment of some of the following topics (check all that apply below):		
a. Atomic and molecular structure	Atomic structure and spectra are studied in the context of spectroscopic observations of emission lines in gases (with discussion of electron energy levels and energy quantization); molecular structure is discussed in the context of chemical reactions (see [c] below)	Tentative Course Calendar (Course Syllabus p. 4), April 19-21; April 26-28
b. Electrical processes	Electrical processes are discussed through investigations of electrical forces (interactions of charged objects, Coulomb's law), electrical circuits (batteries and bulbs, measurements of current, resistance, and voltage), and electrical energy and power (observations of electrical heating effects, electrical power dissipation, electrical and mechanical energy transfer through motors and generators, etc.).	Tentative Course Calendar (Course Syllabus p. 3); March 1-3; March 8-10

Course Prefix	Number	Title	Designation
SCN	250	Physical Science by Inquiry	SQ

Explain in detail which student activities correspond to the specific designation criteria. Please use the following organizer to explain how the criteria are being met.

Criteria (from checksheet)	How course meets spirit (contextualize specific examples in next column)	Please provide detailed evidence of how course meets criteria (i.e., where in syllabus)
c. Chemical processes	Chemical processes are discussed through observations of reactions (including endothermic, exothermic, and acid/base) that produce temperature changes, precipitates, color changes, and/or gases; energy transformations in bond breaking and forming are discussed in relation to analogous phenomena with permanent magnets.	Tentative Course Calendar (Course Syllabus p. 4), April 19-21; April 26-28
d. Elementary thermodynamics	Elementary thermodynamical ideas are introduced through the notion of thermal equilibrium in the context of temperature changes of, and energy transfers between, varying masses (of water and metals) at different initial temperatures, and through investigations of relationships among pressure, volume, and temperature of gases when mechanical work is done on gases in plastic syringes [i.e. energy transfer via work].	Tentative Course Calendar (Course Syllabus p. 3), February 15-17

Course Prefix	**Number**	**Title**	**Designation**
SCN	250	Physical Science by Inquiry	SQ

Explain in detail which student activities correspond to the specific designation criteria. Please use the following organizer to explain how the criteria are being met.

Criteria (from checksheet)	**How course meets spirit (contextualize specific examples in next column)**	**Please provide detailed evidence of how course meets criteria (i.e., where in syllabus)**
e. Electromagnetics	Electromagnetic phenomena are explored through detailed investigations of magnets, magnetic fields, electromagnets, electromagnetic induction, and generation of electrical power, including study and construction of electrical motors and generators; discussion of creation and detection of electromagnetic waves.	Tentative Course Calendar (Course Syllabus p. 3), March 22-24; March 29-31; April 5
f. Dynamics and mechanics	After introduction of kinematic concepts (displacement, velocity, and acceleration), students are introduced to forces and carry out investigations of the relationship between force and motion leading to the formulation of Newton's laws of motion, as well as concepts of kinetic and potential energy and energy transformations (conservation of mechanical energy).	Tentative Course Calendar (Course Syllabus p. 3), February 1-3; February 8-10

SCN 250 Physical Science by Inquiry
Designation: SQ
Mary Lou FultonTeachers College

Course Description

I. Introduction
This course is a lab-based introduction to physical science that, although targeted particularly at elementary education majors, is also appropriate for and open to majors in all fields. There are no stated prerequisites, since general high-school-level knowledge of mathematics and science is considerated adequate preparation. This course has been successfully taught twice with the omnibus designation SCN 294; the SQ designation was requested and obtained for both of those offerings. This present submission is essentially the same as the original submission that yielded the SQ designation for SCN 294.

II. Overview
This course is a laboratory-based development of concepts and reasoning skills in the physical sciences. It takes place entirely in an instructional laboratory room, and laboratory activities and lectures are closely woven together. The enrollment will be capped at around 25 students per section to ensure a high level of instructor contact with the student groups as they carry out their laboratory investigations.

The emphasis in the course is on open-ended, hands-on laboratory investigations, in which students are guided through dialogues with the instructor as well as by small group discussions. The aim of the course is to help students think of physical science as an active process of discovery in which they can participate. It is particularly intended to help preservice teachers understand inquiry and develop inquiry skills. Liberal arts students who take the course will gain first-hand experience in the scientific process by carrying out genuine laboratory investigations in which the outcome is not known in advance, and which they will have a significant role in designing. This course is intended to be useful for students who wish to improve their science preparation before taking further science courses. It forms a firm foundation for scientific literacy for students in all fields, and similar courses at other universities have been found valuable even by students majoring in scientific and technical fields.

III. Course Format
This course will involve laboratory work and discussion with a minimum of lecture. Students will be involved in a variety of activities that will help them develop the knowledge, skills, and practices necessary to understand, apply, and communicate concepts of modern physical science. Weekly activities will include hands-on laboratory investigations, group discussions, group presentations, assigned readings, and written reports. Instructors will interact with students primarily by asking guiding questions, posing problems, and offering hints and suggestions.

Most of the class time will be taken up by various student activities, such as group work using laboratory equipment, written problems, and sequences of related questions answered using whiteboards or on paper. Only a small portion of the time will be spent on lecture. The activities focus on crucial physical concepts, the mathematical formalism used to represent those concepts, and key applications. Active participation and teamwork is expected. Qualitative, non-numerical problems will be an important part of the course, and such problems will always appear on homework, quizzes, and exams. The instructor will often ask student groups to offer responses to questions through the use of whiteboards, so that both the instructor and the students can be informed about the progress of each other's thinking. There will occasionally be a short ungraded "pretest," usually at the beginning of the week. These are intended to start students thinking about the material that will be covered that week. Pretests will not be graded or handed back.

IV. Course Activities and Philosophy

Guided by the textbook and by supplemental worksheets, students will work in groups to carry out investigations of basic physical phenomena. They will explore phenomena by using a diverse array of scientific equipment and measuring instruments, and will search for patterns and consistencies among the observed phenomena. They will keep a laboratory notebook in which they maintain a written record of their observations, calculations, answers to questions, and analysis of experimental outcomes, and they will submit weekly reports focused on specified phases of their investigations. These reports will be graded on completeness, thoroughness, and appropriate attention to detail.

Students will attempt to find relationships among the various controllable parameters of physical systems, and will develop mathematical and physical models to predict and explain those relationships. They will design and carry out controlled experiments in which their proposed models are tested by keeping unchanged all but one variable parameter, in order to explore the effects on the system of changing that parameter. This process of forming hypotheses and creating tentative models of physical behavior, and then testing those models by designing and carrying out experiments, is repeated from one week to the next throughout the course. Students will explore the role of uncertainty in their findings by assessing the degree of certainty possible for predictions made from their model, in light of the uncertainties in their observations and their measurements of physical quantities.

Students will make informal presentations of their findings to their classmates during regular class discussions. All students will also be expected to give at least one extended and detailed ($\approx$ 30-minute) formal presentation. The student groups will take turns in presenting the goals, methods, and outcomes of their experimental investigations to their classmates using appropriate media. For example, they might assemble a PowerPoint presentation which would include spreadsheet data and data analysis, graphical presentation of their results, diagrammatic, photographic, and/or video presentation of their procedures and findings, etc.

Through these various activities the students experience the scientific process at first hand, reproducing (albeit in a simplified and carefully guided context) the same activities carried out by real scientists in actual scientific investigations and at scientific conferences at which findings are presented. In this way, the course stresses the nature of basic scientific issues such as how to develop adequate representations of the physical world, methods for designing and implementing effective tests of those representations, and the challenge of effective communication of scientific results. Through this process, the students will develop and deepen their knowledge of the scientific method.

V. Course Goals

The goal of this course is for students to learn to use both qualitative and quantitative methods for understanding, analyzing, and predicting the behavior of physical systems in a wide variety of contexts. The ability to generate mathematical descriptions of the systems should be accompanied by an ability to use diagrammatic methods and verbal descriptions to characterize the nature and behavior of the systems. Through these means students will also develop the ability to predict and control the behavior of diverse physical systems. Through ongoing discussion of the uncertainties inherent in predicting and explaining outcomes of their experiments, students will develop some appreciation of the scope and reality of limitations in scientific capabilities.

VI. Student Learning Outcomes

Students will be able to use both qualitative and quantitative methods for understanding and analyzing physical systems in a wide variety of contexts. They will be able to predict the behavior of such systems using given information or observations they make themselves, through reasoning on the basis of physical laws and principles. They will be able to represent and characterize physical systems with mathematical descriptions as well as with diagrammatic methods and verbal descriptions. They will be able to respond to questions about a wide variety of physical systems, posed in a variety of representations and in diverse contexts.

VII. Required Course Texts, Materials and Resources

The required textbook is *Physics by Inquiry, Vols. 1 and 2*, by Lillian C. McDermott and the Physics Education Group at the University of Washington (Wiley, New York, 1996). This inquiry-based activity guide and text has been developed through 30 years of research on teaching physical science through inquiry, and is used as a course text in similar courses at dozens of universities in the United States. In addition to the course text, the course instructor has developed hundreds of pages of student activity guides, explanatory materials, and quiz, homework, and test questions both on topics covered in the course text and on additional topics that will supplement those in the text. These materials will be made available to the students via Blackboard.

VIII. Tentative Course Calendar with descriptions of activities

*[**Please Note**: dates for specific topics are subject to change; this schedule is only intended to show the planned list of topics and their approximate sequence, either or both of which may change.]*

January 18-20: Introduction: Properties of Matter; Measurement of Mass; Uncertainty of Measurement

Reference: *Physics by Inquiry, Vol. I*, Properties of Matter, Part A

Description of Activities: Students will be introduced to operational definitions of mass in the context of activities using an equal-arm balance. They will engage in proportional reasoning activities as they convert among several different mass units. They will be introduced to the nature of experimental uncertainty by making multiple measurements (with milligram precision) of a single object, encountering a range of numerical values for which they will have to estimate the uncertainty. They will be introduced to measurements of area, volume, and density and will address issues of uncertainty of measurement in those values as well.

January 25-27: Measurements of Area, Volume, and Density; Graphical Representations; Sinking and Floating Behavior

Reference: *Physics by Inquiry, Vol. I*, Properties of Matter, Parts A, B, and C

Description of Activities: Students will continue their investigation into properties of matter by determining masses and volumes of a variety of objects and being introduced to the concept of mass density. They will be required to determine both the density and the expected uncertainty in the densities of material objects and liquids by utilizing the uncertainties in their measurements of volume and mass. They will carry out an exploration of sinking and floating behavior and will be challenged to determine which factors influence, and which factors determine such behavior. They will design and carry out controlled experiments to test their models for sinking and floating behavior.

February 1-3: Motion; Displacement, Velocity, and Acceleration; Graphical and Algebraic Representations of Motion

Reference: *Physics by Inquiry, Vol. II*, Kinematics, Parts A, B, C, and D

Description of Activities: Students will be introduced to the concepts of displacement, velocity, and acceleration through experiments using timers and distance-measuring devices. Initially using stopwatches and meter sticks, the activities will progress to the use of ultrasonic motion detectors with real-time computerized graphical displays of distance-time, velocity-time, and acceleration-time graphs. Variable-mass low-friction carts move back and forth, and up and down metal tracks, as students learn to use both graphical and algebraic representations to describe and predict motion. Students will carry out algebraic calculations of distance, time, velocity, and acceleration at the same that they create and analyze graphical representations of the same motion.

February 8-10: Force and Motion; Newton's laws; Gravitation

Reference: Handout materials.

Description of Activities: Students will be introduced to Newton's laws by using calibrated spring scales as well as mass-and-pulley arrangements to apply measured forces to low-friction carts in one-dimensional motion. They will first model and predict the expected relationship between the magnitude of force acting on various masses, and the velocity vs. time behavior (i.e., acceleration) of those masses, and will then design and carry out experiments to test their models. Students will determine mathematical representations of the relationship between force and acceleration and will also explore the directions and magnitudes of forces in mutually interacting objects. They will be introduced to Newton's Universal Law of Gravitation and the nature of inverse-square forces, and will use diagrammatic representations of those forces to explore Newton's third law in the context of gravitating masses.

February 15-17: Heat, Temperature, and Elementary Thermodynamics

Reference: *Physics by Inquiry, Vol. I*, Heat and Temperature, Parts A and B

Description of Activities: Students will explore the changes in temperature of mutually interacting masses of water (and other liquids and solids) that have different initial temperatures. They will make and test predictive models of the relationship between temperature changes, and the masses and initial temperature of the liquids, and will be introduced to the concepts of specific heat and thermal equilibrium. They will explore and graph temperature changes as a function of time, including the case of materials undergoing a phase transition. They will explore the relationship between pressure, volume, and temperature changes of gases through experiments with plastic syringes. The concept of the first law of thermodynamics will be introduced through the relationship between mechanical work done on an insulated system and changes in the temperature (and thus the internal energy) of that system, extending this to the case where volume is held constant while heat transfer takes place.

February 22-24: Work; Oscillatory Motion; Mechanical and Thermal Energy

Reference: Handout materials.

Description of Activities: Students will investigate the behavor of masses oscillating on springs, using ultrasonic motion detectors to observe the mutual relationship of spring extension and mass velocity. This will lead to a discussion of kinetic and potential energy and of conservation of mechanial energy. Students will be asked to represent this behavior using a variety of mathematical and graphical representations, and to use their models to predict outcomes of experiments. Thermal energy will be introduced in the context of temperature changes produced by mechanical work done on liquid and solid systems.

March 1-3: Electric Charges and Electric Fields; Introduction to Electrical Circuits

Reference: Handout materials; *Physics by Inquiry, Vol. II,* Electric Circuits, Part A

Description of Activities: Students will explore the interactions of small charged objects such as pith balls and pieces of sticky tape, and will focus on the number of different *types* of interacting charge, the relationship between object separation and force magnitude, and the direction of the mutual forces. Students will explore electric field patterns of charged objects by using small "test" charges (such as pith balls suspended from strings) and by drawing diagrams to represent the field patterns. Students will start a new investigation by beginning to investigate behavior of simple circuits contining batteries and bulbs.

March 8-10: Electrical Circuits; Electrical Energy and Power

Reference: *Physics by Inquiry, Vol. II*, Electric Circuits, Parts A, B, C, and D

Description of Activities: Students will carry out investigations of series and parallel circuits containing varying numbers of bulbs and batteries. They will explore the meaning of current, resistance, and voltage, and will develop models that allow them to predict the behavior (e.g., bulb brightness, voltmeter and ammeter readings, etc.) of various circuit arrangements that they have not previously seen. Exploration of the concepts of current, voltage, and resistance (in the context of Ohm's law) will lead to discussions about and investigations of electrical power and electrical energy, utilizing nichrome resistance wire to enable clear quantitative observations in circuits with varying resistance.

March 13-20: Spring Break

March 22-24: Magnetic Forces and Magnetic Fields

Reference: *Physics by Inquiry, Vol. I*, Magnets, Parts A and B

Description of Activities: Students will carry out explorations of magnetic phenomena including visualizations of field patterns with arrays of compasses and iron filings, and mapping of fields using magnetic field probes. Students will investigate the magnetic field pattern of bar magnets and of bar magnets disassembled into smaller pieces. Students will begin investigation of magnetic field patterns of various current-carrying conductors, starting with the field pattern of a long straight conducting wire. Magnetic field direction will be determined using both magnetic compasses and "Magnaprobes," which are small magnetized cylinders pivoted to allow movement in all three dimensions.

March 29-March 31: Electromagnetism, Motors; Generation of Electrical Power

Reference: *Physics by Inquiry, Vol. II*, Electromagnets

Description of Activities: Students will investigate the interactions between permanent magnets and current-carrying conductors of various shapes, beginning with a wire coil to determine its "polarity." This leads toward construction of a simple electric motor and analysis of its operation. Careful investigation of currents induced by changes in magnitude and directions of magnetic fields (such as by moving a strong bar magnet into and out of a wire coil) lead toward a simplified formulation of Faraday's law, and this in turn to construction of simple electric generators and analysis of their operation.

April 5-7: Electromagnetic Waves and Mechanical Waves; Interference of Waves

Reference: Handout materials.

Description of Activities: Students will investigate basic principles of wave behavior using "Slinky" springs, including simulations of interference phenomena and polarization. This will lead into an exploration of interference and diffraction phenomena using laser beams and single- and double-slit patterns of various widths and separations, as well as polarization using plastic polarizers. Students will use graphical representations to analyze interference phenomena. Electromagnetic wave phenomena and properties of EM waves will be discussed in the context of the electromagnetic spectrum, including observations of fluorescence due to irradiation by ultraviolet light.

April 12-14: Light and Optics

Reference: *Physics by Inquiry, Vol. II*, Light and Optics, Parts A and B

Description of Activities: Students will engage in simple observations of reflection and refraction of light, leading to formulation of quantitative relationships among angles of incidence, reflection, and refraction. Image formation by simple lenses will be explored and relationships among object and image distance and magnification will be examined. Simple versions of optical instruments such as microscopes and telescopes will be constructed and their operation analyzed.

April 19-21: Atomic Spectra and Atomic Structure; Nuclei; Elements and Compounds; Periodic Table

Reference: Handout materials.

Description of Activities: Students will observe emission spectra of various gases using a simple spectroscope. This will lead into a discussion of atomic structure and electronic energy levels, including quantization of energy. A brief discussion of nuclear structure will help create a transition to discussion of elements and isotopes, and to distinguishing between elements and compounds. The Periodic Table will be introduced.

April 26-28: Molecular Structure; Chemical reactions

Reference: Handout materials.

Description of Activities: Students will observe outcomes of various chemical reactions such as increases and decreases in temperatures of solutions, production of precipitates, changes of color of acid-base indicators, and production of gases. This will motivate discussion of molecular structure and energy transfers due to breaking and forming of intermolecular chemical bonds.

May 3: Review for Final

Final Exam, Date TBA, May 5-11

IX. Course Assignments

Assignment	*Score/Points*	*APTS Standard Assessed*	*National Science Education Standard Assessed*
Laboratory Notebook and Weekly Reports: *graded on completeness, thoroughness, and appropriate attention to detail*	15	NA	Content Standards A and B
Class Presentations: Student groups will present their findings to the class using verbal and graphical representations, utilizing appropriate media such as PowerPoint, whiteboards, etc.: *graded on clarity and thoroughness*	5	NA	Content Standards A and B
Quizzes (top 10 scores)	30	NA	Content Standards A and B
Homework	25	NA	Content Standards A and B
Take-Home Exam	10	NA	Content Standards A and B
Final Exam	15	NA	Content Standards A and B

X. Grading Scale

A. Grading Policy

1. Students are permitted to bring one sheet (8.5″ × 11″, both sides) to use on all exams and most quizzes. If a note sheet will not be permitted on a quiz, this will be announced well in advance. All exams and quizzes will be "cumulative," and may include material from any part of this course.
2. There will be one or two quizzes each week. They may include both multiple-choice and non-multiple-choice questions, as well as "practical" problems involving the use of lab equipment. The top ten quiz grades will be counted; there will be no make-ups for quizzes.
3. There will be one take-home exam during the semester; it will be announced at least two weeks in advance.
4. Homework will be assigned and graded on a regular basis. There is a 10% per day penalty for late homework (including weekend days). [Note: In general, only one or two of the assigned homework problems, randomly chosen, may be graded, and that will count as the homework grade for that week.]
5. Final Exam is mandatory; students must take the final exam.

B. Scaling of Grades

The final grade will be based on the percentage of total points accumulated, with the following letter equivalents (Plus and minus grades to be determined later):

A: 90%; B: 80%; C: 70%; D: 60%; E: 59% or less.

The instructor reserves the right to lower the above scale, on a class-wide basis, if deemed appropriate. That is, if students hit the above minima, they're guaranteed to get at least the specified grade.

Note: This is the actual syllabus used for SCN 294 in Spring 2011.
The syllabus for SCN 250 will be essentially identical to this.

SCN 294 Physical Science by Inquiry
Mary Lou Fulton Teachers College
Arizona State University
Spring 2011
Course line #26839

Instructor Information:

Dates of classes:	Tuesdays and Thursdays, 1:00 – 3:50 PM, Santan 103, Polytechnic Campus
Instructor:	Dr. David E. Meltzer
Email:	david.meltzer@asu.edu
Work Phone:	480-727-5215
Office Hours:	TBA
Office Location:	Santa Catalina 351E

I. Course Information

i. Catalog Description

Laboratory-based development of concepts and reasoning skills in the physical sciences. Emphasis on open-ended investigations, dialogues between the instructor and individual students, and small group discussions. Helps students think of physical science as an active process of discovery in which they can participate. Helps preservice teachers understand inquiry and develop inquiry skills. Liberal arts students gain experience in the scientific process. Useful for students who wish to improve their science preparation before taking further science courses. Forms foundation for scientific literacy. http://www.asu.edu/catalog/

ii. Course Format

This course will involve laboratory work and discussion with a minimum of lecture. Students will be involved in a variety of activities that will help them develop the knowledge, skills, and practices necessary to understand, apply, and communicate concepts of modern physical science. Weekly activities will include hands-on laboratory investigations, group discussions, group presentations, assigned readings, and written reports. Instructors will interact with students primarily by asking guiding questions, posing problems, and offering hints and suggestions.

iii. Course Activities and Philosophy

Guided by the textbook and by supplemental worksheets, students will work in groups to carry out investigations of basic physical phenomena. They will explore phenomena by using a diverse array of scientific equipment and measuring instruments, and will search for patterns and consistencies among the observed phenomena. They will keep a laboratory notebook in which they maintain a written record of their observations, calculations, answers to questions, and analysis of experimental outcomes, and they will submit weekly reports focused on specified phases of their investigations. They will attempt to find relationships among the various controllable parameters of physical systems, and will develop mathematical and physical models to predict and explain those relationships. They will design and carry out controlled experiments in which their proposed models are tested by keeping unchanged all but one variable parameter, in order to explore the effects on the system of changing that parameter. Through these activities the students will develop and deepen their knowledge of the scientific method.

Students will explore the role of uncertainty in their findings by assessing the degree of certainty possible for predictions made from their model, in light of the uncertainties in their observations and their measurements of physical quantities. Students will also communicate their findings to their classmates through group presentations using scientific representations and scientific language, through verbal and graphical presentations utilizing diverse media.

Through these activities the course stresses the nature of basic scientific issues such as how to develop adequate representations of the physical world, methods for designing and implementing effective tests of those representations, and the challenge of effective communication of scientific results.

iv. Course Goals

The goal of this course is for students to learn to use both qualitative and quantitative methods for understanding, analyzing, and predicting the behavior of physical systems in a wide variety of contexts. The ability to generate mathematical descriptions of the systems should be accompanied by an ability to use diagrammatic methods and verbal descriptions to characterize the nature and behavior of the systems. Through these means students will also develop the ability to predict and control the behavior of diverse physical systems. Through ongoing discusssion of the uncertainties inherent in predicting and explaining outcomes of their experiments, students will develop some appreciation of the scope and reality of limitations in scientific capabilities.

v. Required Course Texts, Materials and Resources

1. L. C. McDermott, *Physics by Inquiry*, Vols. 1 and 2 (Wiley, New York, 1996).
2. Handouts, readings and classroom activities will be provided on Blackboard. Students are expected to print out and bring necessary handouts to class; ASU Blackboard Course Management Website at http://myasucourses.asu.edu (All ASU students have FREE access to this web resource.)

vi. Class Attendance and Activity

1. All students are expected to attend class. In the case of an absence from the classroom, the student will be held accountable for the material covered as well as any announcements made in class.
2. Most of the class time will be taken up by various student activities, such as group work using laboratory equipment, written problems, and sequences of related questions answered using whiteboards or on paper. Only a small portion of the time will be spent on lecture. The activities focus on crucial physical concepts, the mathematical formalism used to represent those concepts, and key applications. Active participation and teamwork is expected
3. Qualitative, non-numerical problems will be an important part of the course, and such problems will always appear on homework, quizzes, and exams. The instructor will often ask student groups to offer responses to questions through the use of whiteboards, so that both the instructor and the students can be informed about the progress of each other's thinking.

4. There will occasionally be a short ungraded "pretest," usually at the beginning of the week. These are intended to start you thinking about the material that will be covered that week. Pretests will not be graded or handed back.
5. No cell-phone use in class. All use of laptops must be related to class activities.

vii. Tentative Course Calendar

*[**Please Note**: dates for specific topics are subject to change; this schedule is only intended to show the planned list of topics and their approximate sequence, either or both of which may change.]*

January 18-20: Introduction: Properties of Matter; Measurement of Mass; Uncertainty of Measurement
Reference: *Physics by Inquiry, Vol. I*, Properties of Matter, Part A

January 25-27: Measurements of Area, Volume, and Density; Graphical Representations; Sinking and Floating Behavior
Reference: *Physics by Inquiry, Vol. I*, Properties of Matter, Parts A, B, and C

February 1-3: Motion; Displacement, Velocity, and Acceleration; Graphical and Algebraic Representations of Motion
Reference: *Physics by Inquiry, Vol. II*, Kinematics, Parts A, B, C, and D

February 8-10: Force and Motion; Newton's laws; Gravitation
Reference: Handout materials.

February 15-17: Heat, Temperature, and Elementary Thermodynamics
Reference: *Physics by Inquiry, Vol. I*, Heat and Temperature, Parts A and B

February 22-24: Work; Oscillatory Motion; Mechanical and Thermal Energy
Reference: Handout materials.

March 1-3: Electric Charges and Electric Fields; Introduction to Electrical Circuits
Reference: Handout materials; *Physics by Inquiry, Vol. II,* Electric Circuits, Part A

March 8-10: Electrical Circuits; Electrical Energy and Power
Reference: *Physics by Inquiry, Vol. II*, Electric Circuits, Parts A, B, C, and D

March 13-20: Spring Break

March 22-24: Magnetic Forces and Magnetic Fields
Reference: *Physics by Inquiry, Vol. I*, Magnets, Parts A and B

March 29-March 31: Electromagnetism, Motors; Generation of Electrical Power
Reference: *Physics by Inquiry, Vol. II*, Electromagnets

April 5-7: Electromagnetic Waves and Mechanical Waves; Interference of Waves
Reference: Handout materials.

April 12-14: Light and Optics

Reference: *Physics by Inquiry, Vol. II*, Light and Optics, Parts A and B

April 19-21: Atomic Spectra and Atomic Structure; Nuclei; Elements and Compounds; Periodic Table

Reference: Handout materials.

April 26-28: Molecular Structure; Chemical reactions

Reference: Handout materials.

May 3: Review for Final

Final Exam, Date TBA, May 5-11

viii. Student Learning Outcomes

Students will be able to use both qualitative and quantitative methods for understanding and analyzing physical systems in a wide variety of contexts. They will be able to predict the behavior of systems using given information, through reasoning on the basis of physical laws and principles. They will be able to represent and characterize physical systems with mathematical descriptions as well as with diagrammatic methods and verbal descriptions. They will be able to respond to questions about a wide variety of physical systems, posed in a variety of representations and in diverse contexts.

ix. Course Assignments

Assignment	*Score/Points*	*APTS Standard Assessed*	*National Science Education Standard Assessed*
Laboratory Notebook and Weekly Reports: *graded on completeness, thoroughness, and appropriate attention to detail*	15	NA	Content Standards A and B
Class Presentations: Student groups will present their findings to the class using verbal and graphical representations, utilizing appropriate media such as PowerPoint, whiteboards, etc.: *graded on clarity and thoroughness*	5	NA	Content Standards A and B
Quizzes (top 10 scores)	30	NA	Content Standards A and B
Homework	25	NA	Content Standards A and B
Take-Home Exam	10	NA	Content Standards A and B
Final Exam	15	NA	Content Standards A and B

x. Rubric for Signature Assignment

There is no signature assignment for this course.

xi. Grading Scale

A. Grading Policy

1. You may bring one sheet (8.5″ × 11″, both sides) to use on all exams and most quizzes. If a note sheet will not be permitted on a quiz, this will be announced well in advance. All exams and quizzes will be "cumulative," and may include material from any part of this course.
2. There will be one or two quizzes each week. They may include both multiple-choice and non-multiple-choice questions, as well as "practical" problems involving the use of lab equipment. The top ten quiz grades will be counted; there will be no make-ups for quizzes.
3. There will be one take-home exam during the semester; it will be announced at least two weeks in advance.
4. Homework will be assigned and graded on a regular basis. There is a 10% per day penalty for late homework (including weekend days). [Note: In general, only one or two of the assigned homework problems, randomly chosen, may be graded, and that will count as the homework grade for that week.]
5. Final Exam (mandatory): You must take the final exam.

B. Scaling of Grades

The final grade will be based on the percentage of total points accumulated, with the following letter equivalents (Plus and minus grades to be determined later):

A: 90%; B: 80%; C: 70%; D: 60%; E: 59% or less.

The instructor reserves the right to lower the above scale, on a class-wide basis, if deemed appropriate. That is, if you hit the above minima, you're guaranteed to get at least the specified grade.

xii. Course/Instructor Evaluation

The course/instructor evaluation for this course will be conducted online 7-10 days before the last official day of classes of each semester or summer session. Response(s) to the course/instructor are anonymous and will not be returned to your instructor until after grades have been submitted. The use of a course/instructor evaluation is an important process that allows our college to (1) help faculty improve their instruction, (2) help administrators evaluate instructional quality, (3) ensure high standards of teaching, and (4) ultimately improve instruction and student learning over time. Completion of the evaluation is not required for you to pass this class and will not affect your grade, but your cooperation and participation in this process is critical. About two weeks before the class finishes, watch for an e-mail with "ASU Course/Instructor Evaluation" in the subject heading. The email will be sent to your official ASU e-mail address, so make sure ASU has your current email address on file. You can check this online at the following URL: http://www.asu.edu/emailsignup.

II. University/Mary Lou Fulton Teachers College Policies

- Professional Behavior

It is expected that students exhibit professional behavior inside the classroom, during intern placements, and working with other students outside of the class on assignments related to this class in addition to behavior in the classroom on ASU's campus. If at any time your behavior is "unprofessional," the instructor may refer the student to the Director of the Advising, Recruitment, and Retention Office (ARRO) for the development of a Professional Improvement Plan (PIP).

- **Attendance and Participation**

  All students are expected to attend class. In the case of an absence from the classroom, the student will be held accountable for the material covered as well as any announcements made in class

- **Late and Missing Assignments**

  There is a 10% per day penalty for late homework and other written assignments (including weekend days).

- **Academic Integrity/Plagiarism**

  The ASU Student Handbook contains the following information: "The highest standards of academic integrity are expected of all students. The failure of any student to meet these standards may result in suspension or expulsion from the university and/or other sanctions as specified in the academic integrity policies of the individual academic unit. Violations of academic integrity include, but are not limited to, cheating, fabrication, tampering, plagiarism, or facilitating such activities. The university and unit academic integrity policies are available from the Office of the Executive Vice President and Provost of the University and from the deans of the individual academic units."

  The rest of the code, which consists of several pages, is available at the following URL. http://www.asu.edu/studentaffairs/studentlife/judicial/academic_integrity.htm.

- **Disability Accommodations for Students**

  Students who feel they may need a disability accommodation(s) in class must provide documentation from the Disability Resource Center (Downtown campus UCB 160, Polytechnic campus Sutton Hall 240, Tempe campus Matthews Center, or West campus UCB 130) to the class instructor verifying the need for an accommodation and the type of accommodation that is appropriate. Students who wish accommodations for a disability should contact DRC as early as possible (i.e. before the beginning of the semester) to assure appropriate accommodations can be provided. It is the student's responsibility to make the first contact with the DRC.

- **Religious Accommodations for Students**

  Students who need to be absent from class due to the observance of a religious holiday or participate in required religious functions must notify the faculty member in writing as far in advance of the holiday/obligation as possible. Students will need to identify the specific holiday or obligatory function to the faculty member. Students will not be penalized for missing class due to religious obligations/holiday observance. The student should contact the class instructor to make arrangements for making up tests/assignments within a reasonable time.

- **Military Personnel Statement**
  A student who is a member of the National Guard, Reserve, or other U.S. Armed Forces branch and is unable to complete classes because of military activation may request complete or partial administrative unrestricted withdrawals or incompletes depending on the timing of the activation. For information, please see http://www.asu.edu/aad/manuals/usi/usi201-18.html.

- **Harassment Prohibited**
  ASU policy prohibits harassment on the basis of race, sex, gender identity, age, religion, national origin, disability, sexual orientation, Vietnam era veteran status and other protected veteran status. Violations of this policy may result in disciplinary action, including termination of employees or expulsion of students. Contact Student Life (Downtown campus 522 N. Central Ave., Post Office Room 247, 480-496-4111; Polytechnic campus Administration building suite 102, 480-727-1060; Tempe campus Student Services Building room 263, 480-965-6547; or the West campus UCB 301, 602-543-8152) if you feel another student is harassing you based on any of the factors above; contact EO/AA (480-965-5057) if you feel an ASU employee is harassing you based on any of the factors above.

- **Grade Appeals**
  The professional responsibility for assigning grades is vested in the instructor of the course, and requires the careful application of professional judgment. A student wishing to appeal a grade must first meet with the instructor who assigned the grade to try to resolve the dispute. The process for grade appeals is set forth in the undergraduate and graduate catalogs, which are available at http://www.asu.edu/catalog

- **Cell Phone Policy**
  Cell phone use is not permitted in class.You must leave the room for any necessary use of cell phones and smartphones.

- **Electronic Communication**
  Acceptable use of university computers, internet and electronic communications can be found in the Student Code of Conduct (http://www.asu.edu/aad/manuals/usi/usi104-01.html) and in the University's Computer, Internet, and Electronic Communications Policy (http://www.asu.edu/aad/manuals/acd/acd125.html).

- **Technological Services and Support**
  The Mary Lou Fulton Teachers College encourages students to make use of technological services available through ASU to make their learning experience more efficient. Students with personal laptop computers or netbooks can connect wirelessly to the Internet and to printing services on all four campuses and some PDS sites. The following support services are available to support student computing needs.

  Student Purchases:
  Discounted pricing for students purchasing laptop or desktop computers is available at through the ASU bookstore or online. (http://gomobile.asu.edu/)

The John Babb Scholarship provides $500 financial reimbursement for qualified students. (http://gomobile.asu.edu/content/scholarship-info)

ASU Campus Classroom Connectivity:
In-class use of laptops is encouraged by the Mary Lou Fulton Teachers College.
In cases where students need to make presentations during class, most classrooms have the capability of allowing laptops to connect to classroom projectors. Mac laptops may require an adaptor. For collaborative work, social networking tools are provided to ASU students through a Google partnership, including Google docs, spreadsheets, presentations, forms, and sites. (https://docs.google.com/a/asu.edu/#all)

Hardware and Software Support:
ASU 1:1 Technology Studios provide support to students on all four campuses for hardware, software and operating systems, security, networking, etc. (http://help.asu.edu/ASU_1to1_Technology_Studio) Virus scan software downloads are available free for students. (https://webapp3.asu.edu/myapps/) MyApps provides free software tools, online applications, and information about discounted software for purchase. (https://webapp3.asu.edu/myapps/)

PHYSICS BY INQUIRY

An introduction to physics and the physical sciences

Volume I

Lillian C. McDermott
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University of Washington

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