



MAJOR FIELD TESTS

Colleges and universities use the Major Field Tests to measure student academic achievement and growth and to assess the educational outcomes of their major programs. In addition, academic departments use the Major Field Tests to evaluate their curricula and to measure the progress of their students. The tests also provide students with an assessment of their own level of achievement within a field of study compared to that of students in their program and to national comparative data.

Background

Development of the Major Field Tests began in 1989, modeled on the development of the Graduate Record Examinations® (GRE®) Subject Tests. However, unlike the GRE Subject Tests, the Major Field Tests do not serve as a predictor of graduate school success, but are designed to measure the basic knowledge and understanding achieved by senior undergraduates in their major field of study. Each test is revised approximately every five years. Experienced teaching faculty members representing all the relevant areas of a discipline participate in determining test specifications, questions, and types of scores reported. ETS assessment experts subject each question to rigorous tests of sensitivity and reliability. In addition, every effort is made to include questions that assess the most common and most important topics and skills within each major field of study.

Test Content

The Major Field Tests are designed to assess mastery of concepts, principles, and knowledge expected of students at the conclusion of an academic major in specific subject areas. In addition to factual knowledge, the tests evaluate students' abilities to analyze and solve problems, understand relationships, and interpret material. The tests may contain questions that require interpretation of graphs, diagrams, and charts based on material related to the field. Academic departments may add up to 50 additional locally written questions to test areas of a discipline that may be unique to the department or institution.

Test Length

All Major Field Tests are multiple-choice exams lasting two hours (three hours for MBA), and administered in a proctored environment. However, the addition of optional locally developed questions may result in a longer testing period.

Test Administration

Departments or schools choose when and where to give the tests; however, the tests are normally administered during the senior year when students have completed the majority of courses in the major. Many institutions administer the tests as part of the requirements of a capstone course.

National Comparative Data

A Comparative Data Guide, published each year, contains tables of scale scores and percentiles for individual student scores, departmental mean scores, and any subscores or group assessment indicators that the tests may support. The tables of data are drawn from senior-level test takers at a large number of diverse institutions. More than 500 colleges and universities employ one or more of the Major Field Tests for student achievement and curriculum evaluation each year.

Scores

Major Field Test score reports are sent directly to the office within an institution that purchases them, such as a department chairperson, dean, or director of testing. Results of the tests are reported for the entire group of test takers, as well as for individual students. Overall student scores are reported on a scale of 120–200; subscores (which many of the tests include) are reported on a scale of 20–100. Another score reported for most of the tests is based on group-level achievement in subfields of the discipline. These “assessment indicators” report the average percent of a subset of test questions answered correctly by all students tested. On Major Field Tests, only correct answers are scored, so students are not penalized for omissions or guesses.

PHYSICS (4AMF)

(Current form introduced in 2004)

The Major Field Test in Physics consists of 70 multiple-choice questions, some of which are grouped in sets and based on such materials as diagrams, graphs, experimental data, and descriptions of physical situations.

The emphasis of the test is on the students' firm grasp of fundamental principles and their ability to apply an understanding of them in the solution of problems. Most of the test questions can be answered on the basis of a mastery of the first three years of undergraduate physics. The International System (SI) of units is used predominantly in this test. The test contains a table of information that presents various physical constants and a few conversion factors among SI units. Whenever necessary, additional values of physical constants are printed with the text of the questions. Test questions are constructed to simplify mathematical manipulations. As a result, calculators are not needed.

The approximate percentages of content topics are chosen to reflect the relative emphases placed on these topics in most undergraduate curricula. These percentages are given below next to each content category.

The distribution of topics is as follows:

- I. Classical Mechanics and Relativity -- topics include central forces and celestial mechanics (Kepler's laws, Newton's law of universal gravitation, satellites); collisions; conservation laws (energy, momentum, angular momentum); dynamics of a particle; energy and work; fluid mechanics; kinematics (velocity, acceleration, uniform circular motion, constant acceleration, projectile motion); Newton's laws of motion and force; noninertial frames; periodic/oscillatory motion; rotation of rigid bodies about a fixed axis; four-vectors; fundamental concepts in special relativity; length contraction; Lorentz transformations; relativistic dynamics; relativistic energy and momentum; simultaneity; time dilation; velocity addition. (19 percent)
- II. Electromagnetism -- topics include AC circuits; current, resistance, and DC circuits (Ohm's law, Kirchhoff's laws); capacitance; electromagnetic waves; electrostatics (Coulomb's law, electric field, electric potential, electric potential energy, electric flux, Gauss's law); Faraday's law of induction and motional emf; Lenz's law; Lorentz force law; magnetic fields in free space (Ampere's law, Biot-Savart law, magnetic flux, Gauss's law of magnetism); magnetic and electric fields in matter; Maxwell's equations. (17 percent)
- III. Optics and Waves; Thermodynamics and Statistical Mechanics -- topics include diffraction; Doppler effect; geometrical optics; interference; physical optics; polarization; superposition; wave properties; calorimetry; ensembles; entropy; equations of state; ideal gases; kinetic theory of gases; laws of thermodynamics; statistical concepts; thermodynamic processes; transfer of heat. (18 percent)
- IV. Quantum Mechanics and Atomic Physics -- topics include angular momentum; fundamental concepts of quantum mechanics (commutation relations, eigenfunctions, eigenvalues, expectation values, operators, orthonormality, wave function); Heisenberg uncertainty principle; Pauli exclusion principle; perturbation theory; Schrödinger equation solutions; spin; wave function symmetry; atomic spectra; atomic structure; atoms in electric and magnetic fields; blackbody radiation; Bohr model; de Broglie wavelength; energy quantization; molecules; properties of electrons; properties of photons; selection rules; X rays. (23 percent)
- V. Special Topics -- topics include condensed matter physics (basic concepts, crystal structure, diffraction, free electron theory, semiconductors, superconductors, thermal properties); nuclear and particle physics (fission and fusion, nuclear reactions, nuclear properties, radioactive decay, particles and interactions); laboratory methods (counting statistics, data and error analysis, dimensional analysis, electronics, instrumentation, lasers, probability and statistics, radiation detection); Lagrangian and Hamiltonian formalism (Lagrangian, Lagrange's equations of motion, Hamiltonian, Hamilton's equations of motion). (17 percent)
- VI. Miscellaneous Topics -- topics include astrophysics; computer applications; mathematical methods. (6 percent)

The relative percentage of physics questions presented in various settings is as follows:

- A. Verbal – qualitative questions in which the stem and options consist primarily of words. (25 percent)
- B. Pictorial/Spatial – Questions in which the stem or options involve pictures, diagrams, or vectors (but not graphs). Analysis or interpretation of the pictures or diagrams, or the determination of the directions of vectors is required to answer the question. Does not include questions in which the pictures or diagrams are only aids to understanding the situation presented. (8 percent)
- C. Graphical – Questions in which the stem or options involve graphs that must be analyzed or must be interpreted to express physical relationships. (10 percent)
- D. Symbolic – Questions involve interpreting, expressing, or manipulating physical relationships in symbolic form. (25 percent)
- E. Numerical – Questions involve choosing among options that are numbers or that differ by numerical coefficients. Questions usually consist of substituting numerical values in one or more equations and computing an answer, or of determining a numerical coefficient, often manipulating equations symbolically. (32 percent)

The relative percent of physics questions at various cognitive levels is as follows:

- 1. Recall – Involves simply remembering the desired information. (21 percent)
- 2. Single-concept problem – Involves recall and interpretation, translation, or application of a single concept. (48 percent)
- 3. Multiple-concept problem – Involves recall and application of two or more physical concepts in some combination. (31 percent)

Scores on the Major Field Test in Physics are reported as follows:

Total Score

Reported for each student and summarized for the group.

Subscores

Reported for each student and summarized for the group.

-Introductory Physics. (38 questions)

Includes Topics I, II, and III.

-Advanced Physics. (32 questions)

Includes Topics IV, V, and VI

Assessment Indicators:

Reported for the group* only.

I. Classical Mechanics and Relativity (13 questions)

II. Electromagnetism (12 questions)

III. Optics and Waves; Thermodynamics and Statistical Mechanics (13 questions)

IV. Quantum Mechanics and Atomic Physics (16 questions)

V. Special Topics (12 questions)

*A minimum of five (5) students is required in order for assessment indicators to be reported.



Copyright © 2005 by Educational Testing Service. All rights reserved. EDUCATIONAL TESTING SERVICE, ETS, the ETS logo, GRADUATE RECORD EXAMINATIONS, and GRE are registered trademarks of Educational Testing Service. HIGHER EDUCATION ASSESSMENT is a trademark of Educational Testing Service.

Permission to reproduce this document is hereby granted to institutions (colleges and universities) administering the Major Field Tests for internal use only. No commercial or further distribution is permitted. Other persons or agencies wishing to obtain permission to reproduce this material may write to the Permissions Administrator at Educational Testing Service, Princeton, New Jersey 08541.