Find out how to prove — and improve — the effectiveness of your *Physics* program with the ETS® Major Field Tests.

Content Validity

The Major Field Test (MFT) in Physics, first administered in 1989, assesses mastery of concepts, principles and knowledge by graduating Physics students. To ensure fairness and content relevance, the test is revised approximately every four to five years.

Developed by Leading Educators in the Field

Experienced faculty members representing all of the relevant areas of the discipline determine test specifications, questions and types of scores reported. ETS assessment experts subject each question to rigorous tests of sensitivity and reliability. Every effort is made to include questions that assess the most common and important topics and skills.

In addition to factual knowledge, the test evaluates students' abilities to analyze and solve problems, understand relationships and interpret material. Questions that require interpretation of graphs, diagrams and charts are included. Academic departments may add up to two subgroups and as many as 50 additional locally written questions to test areas of the discipline that may be unique to the department or institution.

National Comparative Data

A *Comparative Data Guide*, published each year, contains tables of scaled scores and percentiles for individual student scores, departmental mean scores and any subscores or group assessment indicators that the test may support. The tables of data are drawn from senior-level test takers at a large number of diverse institutions. Nearly 1,500 colleges and universities employ one or more of the Major Field Tests for student achievement and curriculum evaluation each year.

Who Develops the MFT in Physics?

Individuals who serve or recently have served on the Committee for the MFT in Physics are faculty members from the following institutions:

Berry College
Middlebury College
University of Arizona
University of Dallas

For more information about the MFT in Physics:

Phone: **1-800-745-0269**
Email: **highered@ets.org**
Visit: **www.ets.org/mft**

Educational Testing Service
Rosedale Road
Princeton, NJ 08541

Test Content — Physics (4IMF)

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. Programs can choose when and where to administer the test. It is designed to take two hours and may be split into two sessions. This test must be given by a proctor. Mathematical operations do not require the use of a calculator. Reference material is available (under "Exhibits" for online users and inside the test book for paper-and-pencil users).

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. Topics include:

The Test Outline

I. Classical Mechanics and Relativity (~19%): 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

II. Electromagnetism (~17%): 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

III. Optics and Waves, Thermodynamics and Statistical Mechanics (~18%): 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

IV. Quantum Mechanics and Atomic Physics (~23%): 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

V. Special Topics (~17%): 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 (Lagrange's equations of motion, Hamilton's equations of motion)

VI. Miscellaneous Topics (~6%): Astrophysics; computer applications; mathematical methods

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

A. Verbal (~25%): Qualitative questions in which the stem and options consist primarily of words.

B. Pictorial/Spatial (~8%): 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.

C. Graphical (~10%): Questions in which the stem or options involve graphs that must be analyzed or must be interpreted to express physical relationships.

D. Symbolic (~25%): Questions involve interpreting, expressing or manipulating physical relationships in symbolic form.

E. Numerical (~32%): 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.

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

1. Recall (~21%): Involves simply remembering the desired information.

2. Single-concept problem (~48%): Involves recall and interpretation, translation or application of a single concept.

3. Multiple-concept problem (~31%): Involves recall and application of two or more physical concepts in some combination.

How scores for the Major Field Test in Physics are reported:

Total Score — Reported for each student and summarized for the group

Subscores — Reported for each student and summarized for the group

- Introductory Physics (38): Includes Topics I, II and III
- Advanced Physics (32): Includes Topics IV, V and VI

Assessment Indicators — Reported for the group* only

- Classical Mechanics and Relativity (13)
- Electromagnetism (12)
- Optics and Waves; Thermodynamics and Statistical Mechanics (13)
- Quantum Mechanics and Atomic Physics (16)
- Special Topics (12)

Numbers in parentheses are the approximate number of questions in each category.

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