Physics 4601

Physics GRE exam

James C. (JC) Gumbart

http://simbac.gatech.edu/phys4601/

School of Physics | Georgia Tech | Spring 2024
What is the GRE?

- The Graduate Record Examination (GRE) is a set of standardized tests often used for entry to graduate school.
- The **General** GRE test, which is required by most schools, has three parts, quantitative (*math*), verbal (*words and stuff*), and analytical writing (*can you combine words into sentences*).
- Subject GRE tests are used for specific fields (*Biology, Chemistry, Literature, Math, Physics, Psychology*) and are used more or less often, depending on the area.
Why GRE?

Student performance measures that don’t perform

GREs don't predict grad school success. What does?

By Beryl Lieff Benderly | Jun. 7, 2017, 8:30 AM
Why GRE?

GREExit snapshot

Percent of programs at 50 top-ranked U.S. research universities that didn’t require GRE general scores in 2018. (Programs in some disciplines weren’t offered at all universities.)

Change can be slow!

But it can also be fast!

https://www.sciencemag.org/careers/2019/05/wave-graduate-programs-drop-gre-application-requirement

https://www.science.org/content/article/gre-exit-gains-momentum-ph-d-programs-drop-exam-requirement-amid-pandemic
What is the Physics GRE?

- The Physics GRE is 170 minutes and has 100 multiple-choice (five-option) questions.
- It spans practically all of physics with the following breakdown:
  - Classical mechanics (20%)
  - Electromagnetism (18%)
  - Optics and wave phenomena (8%)
  - Thermodynamics and statistical mechanics (10%)
  - Quantum mechanics (13%)
  - Atomic physics (10%)
  - Special relativity (6%)
  - Laboratory methods (6%)
  - Specialized topics (9%)

https://www.ets.org/gre/subject/about/content/physics
What is the Physics GRE?

1. **CLASSICAL MECHANICS — 20%**
(such as kinematics, Newton’s laws, work and energy, oscillatory motion, rotational motion about a fixed axis, dynamics of systems of particles, central forces and celestial mechanics, three-dimensional particle dynamics, Lagrangian and Hamiltonian formalism, non-inertial reference frames, elementary topics in fluid dynamics)

2. **ELECTROMAGNETISM — 18%**
(such as electrostatics, currents and DC circuits, magnetic fields in free space, Lorentz force, induction, Maxwell’s equations and their applications, electromagnetic waves, AC circuits, magnetic and electric fields in matter)

3. **OPTICS AND WAVE PHENOMENA — 8%**
(such as wave properties, superposition, interference, diffraction, geometrical optics, polarization, Doppler effect)

4. **THERMODYNAMICS AND STATISTICAL MECHANICS — 10%**
(such as the laws of thermodynamics, thermodynamic processes, equations of state, ideal gases, kinetic theory, ensembles, statistical concepts and calculation of thermodynamic quantities, thermal expansion and heat transfer)

5. **QUANTUM MECHANICS — 13%**
(such as fundamental concepts, solutions of the Schrödinger equation (including square wells, harmonic oscillators, and hydrogenic atoms), spin, angular momentum, wave function symmetry, elementary perturbation theory)

6. **ATOMIC PHYSICS — 10%**
(such as properties of electrons, Bohr model, energy quantization, atomic structure, atomic spectra, selection rules, black-body radiation, x-rays, atoms in electric and magnetic fields)

7. **SPECIAL RELATIVITY — 6%**
(such as introductory concepts, time dilation, length contraction, simultaneity, energy and momentum, four-vectors and Lorentz transformation, velocity addition)

8. **LABORATORY METHODS — 6%**
(such as data and error analysis, electronics, instrumentation, radiation detection, counting statistics, interaction of charged particles with matter, lasers and optical interferometers, dimensional analysis, fundamental applications of probability and statistics)

9. **SPECIALIZED TOPICS — 9%**
Nuclear and Particle physics (e.g., nuclear properties, radioactive decay, fission and fusion, reactions, fundamental properties of elementary particles), Condensed Matter (e.g., crystal structure, x-ray diffraction, thermal properties, electron theory of metals, semiconductors, superconductors), Miscellaneous (e.g., astrophysics, mathematical methods, computer applications)

*In each category, the subtopics are listed roughly in order of decreasing importance for inclusion in the test.*
What is the Physics GRE?

- It’s offered only three times per year: September, October, and April
- You register at least a month in advance, but don’t wait until the deadline as **testing centers fill up**!
- Scores take 2-4 weeks to become available
- Many students register for both September and October test dates to increase their chances of getting a good score
- Each test costs $150, which includes sending the scores to **four** schools
- Sending to additional schools costs $35 each
- The **ScoreSelect** option allows you to send only your best score to a school (although **some** schools may ask for all scores anyway)

**BUT** there is an at-home option as well!

Why physics GRE?

Typical physics Ph.D. admissions criteria limit access to underrepresented groups but fail to predict doctoral completion.

Casey W. Miller¹,*, Benjamin M. Zwickl², Julie R. Posselt², Rachel T. Silvestrini³ and Theodore Hodapp⁵

¹School of Chemistry and Materials Science, Rochester Institute of Technology, 85 Lomb Memorial Drive, Rochester, NY 14623, USA.
²School of Physics and Astronomy, Rochester Institute of Technology, 85 Lomb Memorial Drive, Rochester, NY 14623, USA.
³Rossier School of Education, University of Southern California, 3470 Trousdale Parkway, Los Angeles, CA 90089, USA.
⁴Industrial and Systems Engineering Department, Rochester Institute of Technology, 85 Lomb Memorial Drive, Rochester, NY 14623, USA.
⁵American Physical Society, One Physics Ellipse, College Park, MD 20740, USA.

“...despite a large sample size and wide dynamic range, we do not find a statistically significant relationship between GRE Physics (GRE-P) Subject Test scores and Ph.D. completion.”

Do GRE scores help predict getting a physics Ph.D.? A comment on a paper by Miller et al. 

M.B. Weissman

Why physics GRE?

Only 1/15 of schools require it and 1/8 recommend it (was 1/11 and 1/7 last year)

About 4/5 of schools don’t want/need it

Linear fit to trend predicts no school will recommend/require it by 2027

https://docs.google.com/spreadsheets/d/19UhYToXOPZkZ3CM469ru3Uwk4584CmzZyAVVwQJJcyc/edit
Scores

- Every Subject Test yields a total score on a 200 to 990 score scale, in 10-point increments.

- Scores get assigned a percentile representing what fraction of people for which you scored higher (this will vary a bit from year to year).

- For 20,700 people who took the Physics GRE between July 2015 and June 2018, the average score was 712 +/− 160

Scores

• The number of correct answers will determine your score for a given test

• Incorrect answers are NOT penalized (this wasn’t always the case - beware outdated advice!)

• For the 2013 practice exam, getting 84/100 was good enough for a perfect score (990)

• getting 50/100 correct on this test is a 650 - a respectable score (but not competitive for top schools)
Scores

• While some schools publish minimum scores, they aren’t always strictly enforced (GT did not enforce its own minimum)
• To get an idea, you can look at the physicsgre.com forum, e.g.: https://physicsgre.com/viewtopic.php?f=3&t=182278
Resources for preparation

- links to various content on the course website, including old tests for practice with solutions

**Physics GRE details**

Important Dates:
Spring tests: Offered April 7 - April 20, 2024

**How to ace the GRE**
- Web Forum
- Practice Exams
- Solutions (most)
- Conquering the Physics GRE (book)
- Ohio State problem sets and solutions
- List of schools and Physics GRE requirements

- practice tests are most representative but to supplement, a book like this one can be helpful

Strategies

• READ all the sources I have provided/linked to
• Do ALL 500 practice exam problems AND understand them
  • Note: older practice exams are harder than current ones!
• Time is short (~100 seconds/question)! Look for/learn shortcuts for solving problems
• If you have taken sufficient courses, consider taking the April test - then you can decide if you still want to take a second test in October