

Oberlin College Department of Physics and Astronomy Assessment Report, 2008–2009

Student Achievement Objectives for Majors

A student graduating from Oberlin College with a major in physics will possess:

A knowledge of physics. The student will

- have a qualitative grasp of the way things work (e.g., force is related to acceleration, a magnetic field is associated with a changing electric field, confined particles have quantized energies);
- know the basic laws of physics and their range of application (e.g., Maxwell's equations, conservation of momentum, the Schrödinger equation);
- understand experimental evidence for the basic laws and the role of measurement in science;
- have a general awareness of what fields of physics are the subject of current investigation;
- know career paths that are available with a bachelor's degree in physics.

Problem solving skills. The student will be able to

- identify important concepts and ignore irrelevant data;
- use simple techniques (e.g., dimensional analysis, limiting cases, symmetry, back-of-the-envelope estimates), both as rough solutions and as tests of more detailed solution techniques;
- use physical intuition to guess the character of a solution without actually solving the problem;
- translate physical concepts into mathematical language;
- use sound reasoning and detect flaws in logic;
- use computer skills such as symbolic and numerical analysis, write simple programs, and know when a computational approach is appropriate;
- carry out detailed solutions (e.g., solving algebraic, differential, and integral equations).

Experimental skills. The student will be able to

- take measurements of physical phenomena (e.g., electrical, magnetic, and/or optical signals);
- use equipment (e.g., vacuum systems, cryostats) to control experimental conditions;
- understand and take necessary safety precautions;
- document experimental results;
- design experiments, including developing procedures for optimal data collection;
- analyze data using relevant curve fitting and error analysis methods.

Communication skills. The student will be able to

- present physics to technical and non-technical audiences;
- write technical papers that are accurate, clear, and concise;
- locate, evaluate, and use appropriate electronic and print resources;
- convey information using graphs, drawings, and pictures.

Indirect measures

In the senior survey, our 11 graduating majors were asked to grade the department on a five-point scale (5 being good) concerning each of the 22 points listed above. They were also asked to rate the quality of advising and the overall quality of the department. (Survey is included as an appendix.) Numerical average results are:

Physics knowledge	
Qualitative grasp	4.36
Basic laws	4.00
Experimental evidence	4.09
Current investigations	3.59
Career paths	2.55
Problem solving skills	
Identify concepts	4.18
Simple techniques	4.45
Physical intuition	3.82
Translate into math	3.77
Sound reasoning	4.00
Computer skills	3.09
Detailed solutions	4.27
Experimental skills	
Measurements	4.45
Equipment	4.27
Safety	4.27
Document	4.45
Experimental design	3.50
Analyze data	4.00
Communication skills	
Present to audience	4.36
Write accurately	3.91
Use text resources	4.00
Visual information	4.64
Advising	4.05
Overall	4.55

Direct measures

The department implemented two direct measures. First, every graduating student was asked to take the ETS Major Field Test in Physics. Seven* of our eleven students did so. The results are easy to state: Compared to national statistics, the mean results for Oberlin in total score; introductory physics subscore; advanced physics subscore; classical mechanics and relativity subscore; electromagnetism subscore; optics, waves, and thermodynamics subscore; quantum mechanics and atomic physics subscore; and special topics subscore were *all in the 95-100 percentile range*.

While the Major Field Test assesses knowledge of physics and problem solving skills, it does not assess experimental skills or communication skills. To fill this gap, we have used information obtained from Physics 314, Intermediate Laboratory — an upper-level course required for all majors. The course has two required lab reports (8-10 pages in length) and two oral presentations (10 minutes each), along with a

* The test was given on Tuesday, 19 May. One of the test takers had run the Cleveland Marathon on the previous Sunday, placing seventh. After the test, we shared tips on dealing with post-marathon pain.

laboratory notebook requirement (documenting procedures and data on seven experiments, each extending over three afternoons). The average grades on the lab reports, presentations, and notebook are presented below. All results have been placed on a 5 point scale, with 5 being excellent, 4 being good, 3 fair, 2 poor, and 1 unacceptable. For fall 2008, there were 12 students in the class.

Objective	Measure	Mean Result
Document experimental results	Average lab notebook score	4.16
Analyze data using relevant curve fitting and error analysis methods	Average lab report score on data analysis	4.42 for report 1 4.69 for report 2
	Average presentation score on data analysis	4.29 for presentation 1 4.25 for presentation 2
Present physics to technical audiences	Average presentation score	4.42 for presentation 1 4.50 for presentation 2
Write technical papers that are accurate, clear, and concise	Average lab report score	4.32 for report 1 4.53 for report 2
Locate, evaluate, and use appropriate electronic and print resources	Average reference section score for lab reports	4.17 for report 1 4.17 for report 2
Convey information using graphs, drawings, and pictures	Average figures/tables/graphs section score for lab reports	4.10 for report 1 4.21 for report 2
	Average presentation score on clarity of figures, graphs	3.92 for presentation 1 4.42 for presentation 2

What we have learned and what we're doing about it

These data are for the most part heartening. It would be good if students learned more about experimental design, physical intuition, and physical model building ("translating into math") but these are notoriously difficult skills to teach. For the past several years, the introductory course Physics 110 has explicitly taught scaling, modeling, and similar skills.

Our majors should definitely have better computer skills, and we have applied to the College for a replacement faculty position in computational physics.

Our students report, and we concur, that they do not know enough about current research in physics or about the career opportunities open to them. In recent years the introductory courses Physics 110 and 111 have offered extra credit to students who attend departmental colloquia. In addition we have been working to attract non-physics-traditional speakers to our colloquia. For example, in the fall of 2008 one speaker was John Ochsendorf, a structural engineer who uses his skills in green design, archeology, and art history. (A few weeks after delivering this colloquium, Ochsendorf was awarded a MacArthur Foundation fellowship.) We attempt to talk to students about possible physics and non-physics careers they could pursue through an annual pizza lunch. Sometimes, due to time pressure, this pizza lunch doesn't happen. But even when it does happen, it's only one pizza lunch to balance the hundreds of lectures and assignments that emphasize, for example, knowledge of the basic laws of physics, or problem solving through differential equations.

Assessment of assessment

It took several years, but we are now at a point where our assessment of majors is in good shape. The most important question is whether it makes sense to continue asking our graduating majors to take the ETS Major Field Test, if all we get out of it is evidence that they're crackerjack physics students. (They're from Oberlin — they're *supposed* to be crackerjack students.) The department will pursue this question with its graduating majors in the spring of 2010. We would appreciate the advice of the Assessment Committee.

Appendix

Department of Physics and Astronomy	Senior Survey Part I	Spring 2009
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We would like to learn how well the Department of Physics and Astronomy served you during your time at Oberlin as well as how this experience may be enhanced for future majors. We'd also like to assess the extent to which our educational objectives are being met. Your input is essential to this evaluation process, so we hope you will fill out this survey.

The survey has two parts. The first part is very short and asks a few factual questions about your program at Oberlin and your plans for the future. The second part, which is separate and anonymous, asks you to evaluate the Physics and Astronomy Department major program, and your experience in it.

Thanks for your help!

The Faculty, Department of Physics and Astronomy

Your Name: _____

1. What are your plans for next year (check all that apply)?

Full or part time employment Fellowship/internship
 Graduate or professional school Travel Unknown
 Other (specify) _____

Please add specific details (if graduate or professional school, give the name of the school and field of study; if a job, give the company name, job location, title, and details; if getting a job now and planning to go to graduate school later, outline your plans):

2. Did you take the Physics Graduate Record Examination? If so, please report your score and comment on your preparation and any ideas you may have for helping future students who will take it.

Score: _____ Percentile _____

Comments:

3. If you majored in another Arts and Sciences department in addition to Physics and Astronomy, please list it:

If you are also receiving a degree from the Conservatory, please indicate your Con major:

4. During your undergraduate years, did you have any research experiences? If so, please say where, when, and with whom you worked (e.g., on-campus or in an off-campus company or laboratory; during the summer, Winter Term, or academic semester; with an Oberlin faculty member or other mentor):

5. What will be your mail and computer addresses next fall? (If you don't know your address for next year, please give us your permanent address so we can contact you there.)

Please return both parts of this survey to Diane Doman, Department of Physics and Astronomy, Wright 112.

THANK YOU!

Department of Physics and Astronomy	Senior Survey Part II	Spring 2009
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Reproduced on the next few pages are the Department's objectives for majors as posted on our web site. Please think about your experience in physics and/or astronomy at Oberlin College, and indicate the extent to which you feel each objective has been met for you. You may write comments at the end of each section in addition to circling numbers.

Objectives for Majors: A student graduating from Oberlin College with a major in physics will possess:

A knowledge of physics – The student will	Extent to which you feel the Physics and Astronomy Department met this objective in your case (circle one):				
have a qualitative grasp of the way things work (e.g., force is related to acceleration, a magnetic field is associated with a changing electric field, confined particles have quantized energies);	1	2	3	4	5
	Not at all			Very well	
know the basic laws of physics and their range of application (e.g., Maxwell's equations, conservation of momentum, the Schrödinger equation);	1	2	3	4	5
	Not at all			Very well	
understand experimental evidence for the basic laws, and the role of measurement in science;	1	2	3	4	5
	Not at all			Very well	
have a general awareness of what fields of physics are the subject of current investigation;	1	2	3	4	5
	Not at all			Very well	
know career paths that are available with a bachelor's degree in physics.	1	2	3	4	5
	Not at all			Very well	

Comments on knowledge of physics?

Problem solving skills – the student will be able to	Extent to which you feel the Physics and Astronomy Department met this objective in your case (circle one):				
identify important concepts and ignore irrelevant data;	1 Not at all	2	3	4	5 Very well
use simple techniques (e.g., dimensional analysis, limiting cases, symmetry, back-of-the-envelope estimates), both as rough solutions and as tests of more detailed solution techniques;	1 Not at all	2	3	4	5 Very well
use physical intuition to guess the character of a solution without actually solving the problem;	1 Not at all	2	3	4	5 Very well
translate physical concepts into mathematical language;	1 Not at all	2	3	4	5 Very well
use sound reasoning and detect flaws in logic;	1 Not at all	2	3	4	5 Very well
use computer skills such as symbolic and numerical analysis, write simple programs, and know when a computational approach is appropriate;	1 Not at all	2	3	4	5 Very well
carry out detailed solutions (e.g., solving algebraic, differential, and integral equations).	1 Not at all	2	3	4	5 Very well

Comments on problem solving skills?

Experimental skills – the student will be able to	Extent to which you feel the Physics and Astronomy Department met this objective in your case (circle one):										
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Comments on experimental skills?

Communication skills – the student will be able to	Extent to which you feel the Physics and Astronomy Department met this objective in your case (circle one):										
present physics to technical and non-technical audiences;	<table style="width: 100%; border: none;"> <tr> <td style="text-align: center;">1</td> <td style="text-align: center;">2</td> <td style="text-align: center;">3</td> <td style="text-align: center;">4</td> <td style="text-align: center;">5</td> </tr> <tr> <td colspan="3" style="text-align: left;">Not at all</td> <td colspan="2" style="text-align: right;">Very well</td> </tr> </table>	1	2	3	4	5	Not at all			Very well	
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Comments on communication skills?

Final Questions

1. If the Department of Physics and Astronomy offered more 300 and 400 level courses, would you have taken any? Yes___ No (Explain)_____

Please list any specific new courses you think should be in our curriculum:

2. If you had a research experience during your undergraduate years, how did it compare to your experience in “normal” courses, in quality and significance for your education?

