

2017-2018 Annual Program Assessment Report: Physics & Astronomy

Please submit report to your department chair or program coordinator, the Associate Dean of your College, and to [james.solomon@csun.edu](mailto:james.solomon@csun.edu), Director of the Office of Academic Assessment and Program Review, by September 30, 2017. You may, but are not required to, submit a separate report for each program, including graduate degree programs, which conducted assessment activities, or you may combine programs in a single report. Please identify your department/program in the file name for your report.

**College:** Science and Math.

**Department:** Physics and Astronomy

**Program:** Physics and Astronomy

**Assessment liaison:** Radha Ranganathan

**1. Please check off whichever is applicable:**

- A.  **Measured student work within program major/options.**
- B.  **Analyzed results of measurement within program major/options.**
- C.  **Applied results of analysis to program review/curriculum/review/revision major/options.**
- D.  **Focused exclusively on the direct assessment measurement of General Education Basic Skills outcomes**

**2. Overview of Annual Assessment Project(s).** On a separate sheet, provide a brief overview of this year's assessment activities, including:

- an explanation for why your department chose the assessment activities (measurement, analysis, application, or GE assessment) that it enacted
- if your department implemented assessment **option A**, identify which program SLOs were assessed (please identify the SLOs in full), in which classes and/or contexts, what assessment instruments were used and the methodology employed, the resulting scores, and the relation between this year's measure of student work and that of past years: (include as an appendix any and all relevant materials that you wish to include)
- if your department implemented assessment **option B**, identify what conclusions were drawn from the analysis of measured results, what changes to the program were planned in response, and the relation between this year's analyses and past and future assessment activities

- if your department implemented **option C**, identify the program modifications that were adopted, and the relation between program modifications and past and future assessment activities
- if your program implemented **option D**, exclusively or simultaneously with **options A, B, and/or C**, identify the basic skill(s) assessed and the precise learning outcomes assessed, the assessment instruments and methodology employed, and the resulting scores
- in what way(s) your assessment activities may reflect the university's commitment to diversity in all its dimensions but especially with respect to underrepresented groups
- any other assessment-related information you wish to include, including SLO revision (especially to ensure continuing alignment between program course offerings and both program and university student learning outcomes), and/or the creation and modification of new assessment instruments

**3. Preview of planned assessment activities for 2017-18.** Include a brief description as reflective of a continuous program of ongoing assessment.

## 2. Overview of Annual Assessment Project(s).

**Note: Planned Activity for 2018-2019 (item 3) immediately follows Assessment Activity in each subsection in item 2.**

### Summary

**1D.** A total of four sections of two GE courses (100 A, 100B) and two sections of PHYS 100 AL were assessed

**1A.** Majors course PHYS 497 was assessed. The Majors course PHYS 497 is a research experience course and serves as a capstone course for assessing program SLOs.

**1B and 1C.** Assessment instrument (planned activity for 2017-2018) for PHYS 465 based on analysis of previous assessments was developed.

**1C.** Proposed a new Research Design Course PHYS 497 in 2016 based on all previous assessments. This course was offered for the first time in S 2018.

### Details

#### 2.1: GE courses

##### 2.1 a. PHYS 100A

##### *SLOs assessed*

1. Demonstrate an understanding of basic knowledge, principles and laws in the natural sciences.
2. Demonstrate an understanding of the logical foundations of science.

*Number of students:* Two sections of PHYS 100A with a total of 208 students; 98 in Section 1 and 110 in Section 2, in F2017 and two sections of 100 B with a total of 179 students were assessed.

*Instrument:* Three multiple choice embedded questions in the Final exam, modified to include descriptive reasoning were used. Unlike in a conventional multiple choice test, students were asked to include descriptions of the reason for their choice and of the basic principles demonstrated by the questions and their answers.

*Method of Assessment:* The percentage of correct answers to each of the questions, reliability interpretation using the point biserial and discrimination index, correlation between the grades on each question based on the multiple choice selection and descriptive answers were used. There were four choices for each question.

Results: (1) PHYS 100 A Section 1 with 98 students:

Correct responses are shown in bold and italics					Blanks	Multiples	Pt. Biserial	Disc. Index	Correct	Pct. Incorrect
Q1	A (36, 36.73%)	B (7, 7.14%)	<b><i>C (51, 52.04%)</i></b>	D (4, 4.08%)	E (0, 0.00%)		0.18	0.91	51, 52.0%	48.0%
Q2	A (41, 41.84%)	B (9, 9.18%)	<b><i>C (45, 45.92%)</i></b>	D (3, 3.06%)	E (0, 0.00%)		0.09	0.86	45, 45.9%	54.1%
Q3	A (26, 26.53%)	<b><i>B (49, 50.00%)</i></b>	C (6, 6.12%)	D (16, 16.33%)	E (0, 0.00%)	X	0	0.79	49, 50.0%	50.0%

(2) PHYS 100 A Section 2; 110 students

For this section Q3 was different from Section 1. Only average scores were provided by the instructor.

Item	% of correct responses
Q1	68
Q2	57
Q3	81

2.1 b. PHYS 100 B. Only average scores were available

Item	% of correct responses	
	Section 1	Section 2
Q1	36	49
Q2	63	63
Q3	73	70

*Analysis:* For reference ([WWW.EDDATA.COM](http://WWW.EDDATA.COM); PRELIMINARY ITEM STATISTICS USING POINT-BISERIAL CORRELATION AND P-VALUES BY SEEMA VARMA, PH.D., EDUCATIONAL DATA SYSTEMS, INC., 15850 CONCORD CIRCLE, SUITE A, MORGAN HILL CA 95037) a rule of thumb proposed is a point biserial value less than 0.1 indicates the question (or item) may be problematic and needs to be examined. The Point Biserial coefficient of Q2 and Q3 are low. When examined for content, the assessment coordinators concluded that these two questions were a little more difficult than Q1 because they required more than one step analysis and some basic algebra. The discrimination indices indicate the “ability of an item to differentiate among students on the basis of how well they know the material” (ref: <http://www.washington.edu/assessment/>). A value of “0.9 means excellent reliability, 0.80 –0.90 very good for a classroom test, 70 – .80 - good for a classroom test”. Based on this statistical theory, the values of the discrimination indices obtained for the three questions used in the present assessment are reliable. Section 2 had higher averages than Section 1. Q3 in Section 2 (different from Q3 in Section 1) while demonstrating a basic important principle was a direct question, qualitative with no algebra required. This could account for the high average score of its response.

The descriptive answers to the multiple choice questions were analyzed for Section 1. (9 of 98 students ( 9 %) had reasoning that were acceptable for all three questions, although not completely satisfactory. The number of students scoring 100 % on the 3 questions was 10. This is an excellent agreement indicating that these students are arriving at answers after analyzing or are able to justify their answers correctly. 4 out of 9 students presented correct reasoning. The descriptions of the other 5 were ambiguous.

Twenty nine students gave reasons that were somewhat correct, still rather vague showing discomfort and lack of confidence in making arguments.

### *3. Planned Activity for PHYS 100 A and 100 B assessments for 2018-2019:*

1. Three sections of 100 A will be assessed with the same instrument: embedded questions in the Final exam requiring short descriptive answers. Teaching methods and practices adopted by the different instructors (whether demonstrations were made, pre-class assignments, use of clicker, practice tests, graded homework etc) will be weighed in to evaluate their impact.

2. The PHYS 100 B instructors will administer an entry and an exit test of the same questions to gauge material learned. Embedded questions in the Final exam will also be used.

### ***2.1 c PHYS 100AL***

SLO assessed

1. Explain how the scientific method is used to obtain new data and advance knowledge.
2. Demonstrate competence in applying the methods of scientific inquiry.

Number of students; 48

EXPERIMENT:

Measurement of the Speed of Light Using a Microwave Oven

INSTRUMENT

Students perform an experiment publicized on Youtube, analyze their own results and critically examine the veracity of the claims in the context of the approach whether it is scientific and contrast it with those that follow the scientific method.

Several YouTube videos exist which claim to measure the speed of light using a microwave oven. The physical principle invoked is that of a standing one dimensional wave (like that on a string) where one can measure the distance between antinodes, multiply by 2 to determine the wavelength of said wave, and then multiply by a known frequency to determine the speed of the waves.

The videos achieve the measurement of the distance between antinodes by disabling the rotating device of the microwave. A food item is then chosen, generally one that melts easily when heated, and placed within the chamber. The food is then microwaved in increments until two melted spots appear. These regions where the food item has been heated are the antinodes of the standing wave inside the chamber. The experimenters then measure the distance between two heated locations and calculate the speed of light using the standard frequency of a microwave oven 2450 GHz.

Most of the videos on YouTube achieve excellent results with errors of less than 10% in most cases. The experimenters claim great success of their method.

Students were asked to watch at least three YouTube videos that claim to measure the speed of light using a microwave oven. They are to choose one of those videos and replicate at home to determine the speed of light. The students need to describe the method they are using, record the measurements taken, write out the calculation, state the measured value of the speed of light, and calculate a percentage error. They are then asked to suggest some probable causes for any discrepancy. Finally, they are asked to determine if this experimental method is valid for measuring the speed of light according to the scientific method.

Student's *interpretation and evaluation* of his/her results were used to determine understanding of the scientific method and its application to this particular experiment.

## RESULTS:

In general, the numerical values for the speed of light obtained using this method are random. Some may be close to those presented in the videos but most are larger. At least some results of discrepancy 30-50% are expected, while even greater errors are sometimes obtained.

The students also obtained random results with some close and many far away.

## THE REALITY OF “SUCCESSFUL” and “FAILED” RESULTS:

There are many reasons why some results obtain numerical values that are close to the actual speed of light. Many of these reasons may be in play for an *edited* and *non-scientific* platform such as YouTube. Some of the more common reasons are: The premise of the experimental method assumes that there is a one dimensional standing wave present in a microwave oven. In reality, assuming that there is a standing wave inside of the microwave chamber, it would be *three* dimensional, not one. This complicates the calculation, but qualitative predictions can be made based on the size of the microwave. Since microwaves are of different sizes many different numerical results using this method will be obtained.

- A result close to the speed of light may be obtained if the dimensions of the microwave allow for oscillations for which the wavelengths of the y- and z- modes are large enough so that those terms become small and only the x dimensions matter
- There is a result bias in the experiment which favors those measurements which obtain the correct answer. Specifically the distance between antinodes being 6.1cm apart.
  - a. Impurities in the food item used may heat more than the bulk of the food creating the appearance of false hot spots which are then chosen for the results bias.
  - b. Since the more heated regions of the food are large in size the choice of where to consider the center of the region is ambiguous enough to allow for a result biased decision to be used.

## STUDENT INTERPRETATIONS:

The students are not presented with any background information, nor are they expected to understand any of the actual physics involved with this experiment. They are only presented with a hypothesis, the results of the “successful” demonstration of the hypothesis, and their own results.

In their written reports the students responded after obtaining their own result.

As expected, the students whose calculated value closely matched the speed of light considered the experiment a success and the method valid.

Not too surprisingly, those students who obtained numerical values with large errors did not question the method. Instead a large majority (90%) of these students blamed the discrepancy on the choice of food item. With the other 10% believing there was a problem with their microwave oven.

During a classroom discussion of the results from all lab groups were presented.

Of note is that when seeing the randomness of the results obtained about 20% of those who had previously reported successful results admitted to performing the experiment several times to improve their result and presenting only those that were “right”.

However, when asked to reconsider the results, the students still did not question the validity of the experiment itself.

**ASSESSMENT:** Instructor’s conclusion from this is that our entering students are of the mindset that demonstrations claiming to be proofs on media need not be questioned, regardless of any counter results. Students did not consider that these experimental claims are not refereed by peers as are scientifically conducted enquiries and also that only those results that suited the purpose were presented.

At the conclusion of the lab discussion the students were told that the method is not valid. Internet is not to be trusted at all times. If the hypothesis were true, the method would work regardless of the microwave used, and regardless of the food item heated.

### *3. Planned Activity for PHYS 100 AL assessment for 2018-2019:*

Perform the experiment earlier in the semester and allow room for discussion

Find another experiment which is actually valid in its claims.

Compare and contrast the two (valid and invalid) with scientific reasoning



**2.2. Assessment activity in Majors courses.**

**2.2 a. PHYS 465.** This is a Senior year laboratory course. Assessment results of 2016-2017 were applied to revamp the course requirements (1C). The experiments in this course are in the field of Optics. Although it is not a capstone course, successful performance of experiments requires knowledge, information, computer and math skills from all other courses. A new format for report submission with well-defined requirements was developed. The changes include:

1. Prelab activity that must be completed before starting an experiment. Prelab activity is a preparation and requires reviewing theoretical material that students have been exposed to in other courses. In this activity SLO 2b is assessed.
2. The lab report is structured with specific questions targeted toward assessing SLOs. There are a total of five parts to the report.

**PHYS 465 Assessment Rubric for each experiment**

<i>SLO</i>	<i>Excellent</i>	<i>Satisfactory</i>	<i>Unsatisfactory</i>	<i>Instrument</i>
<i>2b. Combine insights and techniques from the various courses in the program (integrate knowledge)</i>				<i>Prelab Activity report</i>
<i>2a. Set up laboratory experiments and collect data from observations and experiments: Ability to obtain the refractive index from analysis of Michaelson interferometer experimental data, determine error, and discuss discrepancy with true value</i>				<i>Inspection of set-up by Instructor, quality of uploaded data in item 3 of Report.</i>
<i>2d. Analyze data, provide error analysis test a model or hypothesis by comparing with data.</i>				Item 4 of Lab report

<p><b>2e. Competently use computer tools, including: software programs for data analysis and presentation, numerical analysis, and computer simulations.</b></p>				<p><b>Judged by instructor in class on the ability to obtain data using the computer and software for analyzing data and item 3 of Lab report</b></p>
<p><b>3a. Convey physical concepts with mathematical expressions (quantitative literacy)</b>  <b>4a. Make unbiased and objective judgments of theories and experiments</b></p>				<p>Item 4 of Lab report</p>

Excellent: Prepared with material before class; motivated to get results without much help, help required from Instructor is appropriate.

Satisfactory. Basic preparation with material, just enough to conduct the experiments, requires some help, but eventually understands, exhibits interest in getting good results.

Unsatisfactory: Unprepared; not motivated to get results and does not want to be helped, just presents whatever he / she gets without enquiring if results can be better.

*3.1 Planned Activity for PHYS 465:* Implement the assessment method developed. See Section 2.1a

**2.2. b. PHYS 497.** This is a new Senior level course that was offered for the first time in S 2018. Program SLOs 1 and 3 were assessed.

**1. Physics:** Students will be able to describe natural phenomena in general and in their chosen program option using principles of physics

**3. Communication:** Students will be able to

- a. Convey physical concepts with mathematical expressions (quantitative literacy)
- b. Clearly communicate physical concepts, findings, and interpretations through oral presentations (oral communication)
- c. Write clear, organized and illustrated technical reports with proper references to previous work in the area (written communication)
- d. Search for and read scientific literature (information literacy)

*SLO 1:* The ETS Physics test that our students take at the end of their senior year was used as the instrument to assess SLO 1. We have been using the ETS exam as an exit final assessment.

*Results:* The 497 course is an elective course. Of the total 21 students, 10 took the course and 11 did not. The results of the test are:

Student type	Number of Students	Mean	Median	Std. Dev.	CSUN GPA			percentile
					Mean	Median	Std Dev	
Took PHYS 497 (S2018)	10	148	149	20	3.34	3.28	0.35	50
No Phys 497 (S2018)	11	136	135	11	3.32	3.42	0.25	6
National	~2700	149.9	148	15.4				
Last year (S2017)	15	140	136.5	10				27
S 2016	15	151.5	149	13.3				49
S 2015	4	146	147	8				39

*Analysis:* Students that took the PHYS497 performed better (higher average and median) than those that did not (Rows 1 and 2). Their percentile Of 50 is a significant improvement over the 6<sup>th</sup> percentile of those that did not take the course. The stats of the PHYS 497 group are at about the national level. The average GPA of the two groups compared (Column 6) are similar, indicating that students that took the course did not begin with any apparent advantage over those that did not. So it appears that the preparation in PHYS 497 did help. The difference between the groups that is of significance is that the students in PHYS 497 had the advantage of review sessions, practice tests, and the ETS test results accounted for part of the course grade. Year over year percentiles also show improvement.

*SLO 3.* The assessment rubric presented in the next page was used as the instrument to assess SLO 3. 10 students gave presentations three times throughout the semester and these were ranked with the attached presentation rubric.

PresentationRubric

**Presentation evaluation rubric V2**  
*For every aspect, circle your assessment*

<b>Presenter:</b>		<b>Advisor:</b>		<b>Date:</b>
	<b>Poor</b>	<b>Needs some improvement</b>	<b>Good</b>	<b>Excellent</b>
1	<b>Engagement/ Receptivity to audience</b>	Does not respond, responds incorrectly or inappropriately to questions.	Responds, but answers are not clear or take too long	Ok Answers clearly, to the point
2	<b>Statement of problem</b>	Unclear what problem is being solved and/or why	A little too detailed/specialized	Ok Clear statement of problem and ties into why the approach discussed may work
3	<b>Information accuracy</b>	Gets basic laws of physics wrong	Some technical blemishes	Ok Information is accurate and at right level of detail
4	<b>Information clarity</b>	Not clear what the point is of many of the slides	hard to read or digest slides / too wordy / small fonts / missing figure legends and labels	Ok Really brings every point home
5	<b>Explanation of visual components (figures)</b>	Figures and diagrams unclear and not tied to narrative	Slight disconnect between figures / diagrams and narrative	Ok Figures and diagrams clearly illustrate the points being made and leads the narrative along the talk
6	<b>Organization of talk</b>	Too long introduction, too short introduction, storyline disconnected / lots of back and forth between slides	Some gaps between talk and points being made / needs to skip back and forth between slides	Ok Good balance between introduction, problem explanation, findings, discussion, and conclusions
7	<b>References and attribution</b>	No references at all and no figure attribution	Not clear what work is by presenter and what is being cited	Ok Clear delineation between own work and others. References and attribution complete and verifiable

*Results:* The final presentation score was Mean = 3.5 on a scale of 1-4, with a standard deviation of 0.58.

*Analysis:* This is an acceptable score.

### **3.2 b Preview of planned assessment activities for PHYS 497 2018-19.**

SLO 1 will continue to be assessed with the ETS test and SLO 3 with reviews and possible improvements to the assessment rubric. SLO 2 and 4 will be assessed. The written report will be assessed for SLO 2. For SLO 4 students will conduct case studies of doubtful, irreproducible or fraudulent claims in research. Rubrics will be prepared as instruments.

#### **2. Scientific methods:** Students will be able to

Set up laboratory experiments and collect data from observations and experiments

- a. Combine insights and techniques from the various courses in the program (integrate knowledge)
- b. Derive quantitative predictions from a model through mathematical analysis
- c. Analyze data, provide error analysis, and test a model or hypothesis by comparing with data
- d. Competently use computer tools, including: software programs for data analysis and presentation, numerical analysis, and computer simulations.

#### **4. Responsibility & Ethics:** Students will be able to

- a. Make unbiased and objective judgments of theories and experiments
- b. Maintain integrity in their research and adhere to ethical principles regarding plagiarism, data collection and selective data sampling
- c. Give proper attribution
- d. Practice lab safety

The written report will be assessed for SLO 2. For SLO 4, students will conduct case studies of doubtful, irreproducible or fraudulent claims in research. Rubrics will be prepared as instruments.