Robert S. Cohen

In Spring 1968, Cohen delivered the annual University Lecture under the title "Science: Life and Death". He was appointed to serve on the Advisory Panel in History and Philosophy of Science at the National Science Foundation for a term of three years. He was elected Secretary of the U. S. National Committee of the International Union for the History and Philosophy of Science. He was elected to the Editorial Board of the new journal Foundations of Physics and to the Editorial Board of Philosophy and Phenomenological Research. He served as Visiting Professor of Philosophy at the University of California, San Diego, during the Spring Quarter 1969 where he offered a course on the development of philosophy of physics during the 19th century. He was elected to the Board of Directors of the Wiener Kreis Archiv in Amsterdam, and of the Study Group for the Unity of Knowledge. He continues as a member of the Executive Committee of the international Institute for the Unity of Science. He also continues as a member of the National Counsel of the Federation of American Scientists. He was elected as Member-at-large of the Executive Committee of Section L (History and Philosophy of Science) of the American Association for the Advancedment of Science. He continues as a member of the Executive Committee of the American Physical Society, New England Section. He was elected Secretary of the International Max Raphael Society.

Cohen's teaching obligations in 1969 included PY807, Nature of Time, and PH403-404, Spinoza Seminar.

Among other University committees, Cohen served on the MET Academic Policy Committee and the GRS CGEAS.

R. S. Cohen

Lectures 1968-69

June 24-28, N.S.F. Institute on History and Philosophy of Physics, American University, Washington, D.C.

July 2, Lecture, Union for Research in Higher Education, Nasson College

October 8, Queens College, Humanities Program, "Physics and Philosophy in Eastern Europe"

October 10-12, participated in first Annual Meeting of the Philosophy of Science Association, University of Pittsburgh

October 18-19, lecture, French-American Philosophical Conference, sponsored by the American Philosophical Association and the Cultural Attache, Embassy of France, at SUNY, Oyster Bay, N. Y.

December 12, lecture, Scientific Research Society of America, at Air Force Cambridge Research Center Branch

January 28, TV Program, "After Dinner" (with physics and philosophy students) WGBH-TV

January 30, lecture, Institute of Religious Studies, Jewish Theological Seminary, N. Y.

January 31, general University Lecture, Wesleyan University, Middletown, Conn.

March 5-6, lectures and consultation, Department of Physics, Mt. Holyoke College

March 13-14, AAPT Visiting Scientist Program delegate to Gustavus Adolphus College, St. Peter, Minnesota

March 21, 20th Anniversary lecture, Congregation Mishkan Israel, New Haven, Conn.

March 28-30, lecture, Study Group for the Unity of Knowledge, Austin, Texas.

April 25, University of California, Physics and Philosophy Department lecture, "Time and Causality"

May 19, lecture, San Diego State College, "Kant on Physics"

May 23, lecture, Leo Baeck Temple, Los Angeles, California

June 26, lecture, Annual Meeting, Canadian Association of Physicists, Waterloo, Ont.

Ernesto Corinaldesi

Professor Corinaldesi worked during the summer of 1958 on Calculations of Magnetically Induced Quadrupole Moments in connection with an experimental problem of Professor Roy. In addition he has continued the task of making his "dynamical model of the Pauli principle" relativistic.

Professor Corinaldesi worked with three graduate students during the year, and he has taught both the introductory graduate course on Quantum Mechanics and the second semester of the freshman course for engineers and science majors.

Committees:

Department Committee on Comprehensive Examinations

Department Library Committee

Dean S. Edmonds, Jr.

Professor Edmonds has slowly continued work on his new Varadi-Redhead RF mass spectrometer, which is currently being prepared to measure He^3 - He^4 ratios for the low temperature laboratory. One phase in the development work was brought to completion by Miss Merilyn Priolo and formed the subject of her masters thesis last fall. A resume of this work was presented at the meeting of the American Vacuum Society's New England Section in April. Progress has been delayed this past winter by teaching activities, a lack of supporting funds, and the fact that there has been no masters thesis candidate available to replace Miss Priolo.

Last summer, Professor Edmonds undertook to bring out a department laboratory manual together with Professor Chasen. Concerning this and its background Edmonds writes:

"The principal feature of the undergraduate physics courses this year was the disastrous failure of the teaching laboratories to advance to any reasonable extent the teaching of physics. There are a number of reasons for this which may be enumerated as follows:

1. Inadequacy of the laboratory manuals: the two laboratory manuals, Experiments in Physics, with and without calculus, prepared by Professor Chasan and myself last summer, represent compilations of experiments developed by all members of the department involved in the teaching of the large general physics courses over the last eight years. In particular, many of these experiments were taken, some very directly, from Professor Stipe's earlier laboratory manual Experiments in Physics from which the present volumes should be considered direct descendants. The main purpose of last summers' work was to bring together the Stipe experiments that were in continued use and the various experiments developed by others in the department and existing separately in mimeographed form into two convenient volumes easily used in the courses and removing the large amount of last-minute retyping of ditto masters with which our secretaries had been plagued in previous years. The job of getting two manuals ready for publication so that the finished product could be on the bookstore shelves in time for the start of school in September was a big one, and although Professor Chasan and I did our best with the proof reading, a number of errors, some of them serious, slipped through. Moreover, some of the more advanced experiments in optics, electronics, and modern physics were drawn from writings originally prepared for sophomore and junior level courses and were not reduced in length and content sufficiently for an elementary course. Finally, in the second semester, just when adequate preparation for the more difficult experiments was most needed, two verybad snow storms disrupted lecture schedules to such an extent that in some cases students came to a laboratory without ever before having heard of the subject of the experiment. In defense of the manuals it should, however, be pointed out that in many cases the description of the experiment in the manual was not all that bad and that much of the students' problems could be laid to inadequate preparation, i.e., they hadn't even attempted to read the manual before coming to class. There is nevertheless no doubt that there are grave problems with some of the writeups. The undergraduate committee is well aware of this and will undertake the re-editing of these experiments as required.

Concerning undergraduate teaching, Professor Edmonds has written about a number distinct problems as follows:

Equipment problems: One of the major complaints about the past semester's laboratories was that many of the experimental setups would not work due to defective equipment which could not be repaired or replaced in time. Such occurrences created a general impression of shoddiness in the conduct of our courses which I think extremely unfortunate. I shall speak further on about why such equipment was put out in the lab rooms in the first place. Let me here note only the following: Three years ago we received NSF and NDEA grants for the improvement of the teaching laboratories and accordingly purchased equipment for and installed a number of rather sophisticated experiments. They were well designed and worked beautifully, but they included several items which, though expensive, should nonetheless be regarded as expendable. For instance, the special tube used in the

electron-charge to mass ratio experiment costs $64, yet has a mean life of only eight hours in operation. Thus it is not enough to get such grants and use them to install experiments. One must also be prepared to pay the cost of maintaining this investment. In view of the level of our commitment in undergraduate laboratory instruction, such maintenance may be estimated at $2500. each year. Unfortunately we have not made anything like this outlay since the experiments were installed, until finally this year a large fraction of the light sources, photoelectric cells, e/m tubes, and Franck-Hertz tubes all came to the end of their nature lifetimes and failed more or less simultaneously. It seems that we must organize and fund a spares and replacement program every year to solve this problem. Steps have already been taken to do this for 1969-70, but it should be borne in mind that something along this line must be done every year.

Divided responsibility for a course and its laboratory: An experiment was tried this past year which was intended to bring into the general physics courses faculty members who are gifted teachers but are not particularly conversant with the laboratory and its equipment. Whatawas done was to place such faculty members in charge of courses such as PY105-106 but to assign other faculty members responsibility for the lab. In retrospect I do not consider this idea a success. Perhaps its failure is somewhat my fault, for I was in charge of the PY 106 laboratories and am no little embarrassed at the result. However, I must mention that I also ran PY376, the electronics seminar course, in which I had to both set up and perform all the experiments as demonstrations, iplus PY122 the 6-year medical general physics course, which includes an extensive laboratory. Thus I had in effect three laboratory courses on my hands in one semester. Under this kind of pressure one unfortunately tends to neglect "the other man's course", and although I tried to fight against this all-too-human reaction, I know I could have remedied some of the problems in the PY106 labs had I had more time (and help) to put on them. However, even given plenty of time I'm not sure that the idea of dual responsibility for lectures and labsman is a good one. It often means extra teaching fellow meetings which some of the laboratory instructors find themselves unable to attend and sometimes results in the lecturer and lab man getting out of step or otherwise working at cross-purposes unless very special efforts at coordination are made. In short it is, I believe, easier for one man to run the whole course. If in a given instance the professor is unfamiliar with the workings of the lab, he should have a consultant assigned to him. But I think the overall business of running the course should be his alone.

Inadequate staff support: While the above items make it difficult to run an undergraduate laboratory, their impact on the quality of that laboratory would have been minimized if we had in the position of laboratory curator someone who could recognize that these problems existed, was willing to work under the conditions demanded, and who was competent to handle normal situations of maintenance and repair. Unfortunately the recent incumbent demonstrated the reverse of these qualities, and I believe he must bear a sizeable portion of the blame for this year's experimental debacle."

Professor Edmonds has repeatedly tried to institute a useful course in Electronics. Response has not been satisfactory in previous years. He tried again during the spring semester and he writes about it as follows:

The Electronics Seminar

Last semester PY376, "Physical Electronics" was presented as a seminar in which numerous experiments in electronics were done as demonstrations. The course met twice a week with no separate laboratory and therefore carried only two credits. A total of ten students, (6 graduate and 4 undergraduate) [illegible] of which seven (1 graduate and 6 undergraduate) were registered.

undergraduates needed a regular grade I assigned such grades on the basis of a problem sheet and oral examinations administered individually to each student.

The results seemed very encouraging. I believe the demonstration seminar is an extremely efficient way (in terms of "learning per hour") of presenting electronics, for the student sees the devices, observes how they are assembled into a circuit, and has the performance measured right in front of him, yet the tedious taking of data and plotting of curves by hand is avoided. The increase in efficiency is to a large extent made possible by the fact that good (and therefore expensive) equipment can be made available for ithe single setup required for a demonstration whereas we could not afford to equip a laboratory with several such setups. Thus in taking triode characteristic curves an x-y plotter was used. This instrument not only traces out the curves in a dramatic fashion that reveals just what's ioing on but also produces a complete set of curves in a few minutes. Hence when the demonstration was complete every member of the class had a set which had been taken on an actual tube right before his eyes but which he could nevertheless take home and work over at his leisure. Since the x-y plotter in question cost $1500 and was borrowed from the Low Temperature Laboratory for the demonstration, it is obvious that the advantages of this instrument could not have been made available in a student laboratory.

The one drawback with last term's PY376 was that because of the disparity in the students' background I had to start at a rather elementary level and work up. The short semester further diminished by the big snowstorms consequently did not allow the course to go as far as I would have liked. Next winter I hope that a full year of PY375 -376 can be taught in the above described manner. Under the new system it should fit in very well as a seminar or "half course", and should, when spread over both semesters, contain a far more comprehensive treatment of such subjects as modulation, detection, feedback, servomechanisms, avalanche devices, and logic circuits."

Committees:

Chairman, CLA 6-year Medical Program Physics Course Subcommittee
CLA Pre-medical
GRS Teaching Preparation
University Patent Committee
Chairman, Department Language Examination
Department Committee on Undergraduate Studies

One of the main contributions to BU by the physics department has been the freshman physics course for the CLA - MED six year program. The course teaches Calculus and Physics and - together with them - makes possible a sophisticated introduction to biology in the sophomore year. It also serves as a fundamental introduction to college education for these very able students. The CLA subcommittee on the physics course (PY121-122) has prepared an important memorandum which follows:

Report of the Committee
on the 6-Year CLA - Medical Program
Physics Course

I. Basic Needs

The committee feels that CLA's role in the six-year medical program must fulfill the following three fundamental needs:

(1) The experience in the humanities and social sciences necessary to any liberal education.

(2) The necessary grounding in the basic scientific disciplines needed for contemporary medical science.

(3) Experience in problems of scientific practice, such as experimental design, statistical treatment of data, and use of sophisticated electronic instrumentation.

Up to now, the first two of these have been met by traditional university courses slightly modified to meet the special requirements of excellent students in an accelerated program. The third has been met only in so far as traditional laboratories accompanying elementary science courses can provide such experience. The committee believes that the usual freshman physics laboratory falls rather short in this respect, yet in the 6-year medical program the demands upon it are much greater since the junior-senior research opportunities available to normal undergraduate science majors are not available within the program's crowded schedule. The present report will discuss certain changes in PY 121 and 122 which will allow a more intensive introduction to scientific research techniques than is now possible. More basically, however, we feel the need for an integrated attack to strengthen the program's scientific curriculum. Some of the problems involved can only be approached this way, no unrelated adjustment within an individual course providing an acceptable solution. In particular, the role of computers in the 6-year medical program and the possibility of student participation in summer research should be discussed in this context.

II. The Present Course

As now given, the 6-year CLA-medical program's physics course, designated PY 121 (first semester) and PY 122 (second semester), is a one-year course in general physics following a conventional plan common to many general

[illegible] courses intended for college undergraduate science majors. The other differences are, (1) the inclusion of an introduction to calculus as part of the course, and, (2) a somewhat more accelerated presentation of the material. The teaching of calculus as part of the physics course stems from the 6-year medical program not allowing time for the scheduling of a regular calculus course sequence despite the fact that the students involved are eminently qualified for such a sequence and should have the methods of the calculus at their disposal when taking physics. By the same token, their abilities allow an accelerated teaching of calculus that presents the necessary material in a remarkably short space of time. It is thus possible to combine the necessary mathematical treatment and the physics material in a single course without sacrificing any physics as compared to a regular general physics sequence such as PY 111 and PY 112 for which calculus is a prerequisite. Indeed a great majority of the students have had at least some calculus in high school, and many have had reasonably good training in physics. All are highly motivated and can absorb and put to use an amazing amount of material.

The course has been intentionally patterned after existing general physics courses for science majors rather than leaning towards specific needs of medical work. We believe that training in the scientist's way of approaching the problems nature presents to him and a thorough grounding in the structure of physics that has been built up over the centuries and underlies all areas of scientific specialization is essential to any medical student and perhaps most particularly to talented ones some of whom may go on to do significant research. The committee therefore sees no reason to alter the general structure of PY 121 and 122. An outline of the course as it is now taught is presented in the attached PY 121 and PY 122 lecture and laboratory schedules. Also attached is an outline summarizing the major topics covered.

The textbook presently used is Prof. J. G. Stipe's "The Development of Physical Theories". This text is a direct outgrowth of the course, having been written by Prof. Stipe while he was in charge of PY 121 and 122, and as such includes the necessary mathematical treatment. It has been criticized by some of the students as containing more historical material than is necessary or pertinent, but we believe that this small antidote to the very narrow channeling to which the 6-year medical students are prone is more advantageous than otherwise. The physics is certainly sound and well organized. Any further elucidation of derivations or emphasis on problem-solving that may be necessary is easily carried out in lecture. In addition, a one-hour weekly discussion session is reserved

consideration of assigned problems which provide practice in applying the principles that have been studied. This term an experiment has been carried out in combining the two discussion sections into which the class was divided into a single, consecutive, two-hour session. This has the disadvantage of producing a 40-student section in place of the smaller groups originally intended but allows the instructor to cover more problems rather than having to repeat a problem requested independently in the separate sections. At the present time the single two-hour session is working very effectively, but the committee recommends that two consecutive but distinct one-hour discussion sections be listed as was done in the catalog this year. The discussion instructor can then decide whether or not dealing with the students in relatively small groups outweighs the disadvantage of having to go over the same material twice.

III. Recommended Changes

A. Integration with the Chemistry Course. It has come to the committee's attention that considerable duplication exists between PY 121-122 and the 6-year-medical-program chemistry sequence CH 121-122. Since this latter is entitled Physical Chemistry, it is only natural that many topics normally presented in a general physics course should come up here too. Notable among these are thermodynamics and atomic and molecular physics. It thus appears that the students would be greatly benefitted by an integration of the two courses that would eliminate needless repetition and present all the freshman science material in a unified, well organized whole. To this end we have had a joint meeting of the physics and chemistry subcommittees supplemented by further discussions with Dr. Freck, who is responsible for CH 121 and 122. As a result we recommend that thermodynamics and kinetic theory, (which come up in PY 122 and CH 122 almost simultaneously and which are very thoroughly treated in the chemistry course) be dropped entirely from the physics course to allow time for an expanded treatment of electricity and the associated special field of electronics, which is assuming a role of ever increasing importance in medical practice. The treatment of the Bohr atom and quantum mechanics, on the other hand, would be left largely to PY 122. This presents a somewhat more difficult problem because these subjects come up early in the year in the chemistry course as a prelude to dealing with chemical reactions on an atomic level, whereas they do not appear in the physics course until the modern physics section comes up in April. Nevertheless, we feel that a satisfactory compromise can be reached in which CH 121 introduces the nuclear atom, valence, and the concept of discrete

In optics the students do a rather standard experiment with lenses and mirrors plus two rather nice experiments on interference and diffraction. The mirror-and-lens work is not very thrilling and should really have been done in high school, but since we cannot count on the students' having mastered geometrical optics before coming to B. U. and since optical setups with mirrors and lenses (the microscope, for example) will assume considerable importance for them, we feel it must be retained. We try to make enough equipment available so that the students can both learn the way lenses and mirrors work and apply these principles to the construction of models of optical instruments whose performance can then be studied. Again time sets a limit on how thoroughly this can be done. For the interference and diffraction experiments we have obtained a number of excellent setups which show off the calculated patterns beautifully. The equipment is difficult enough to adjust to challenge the students' abilities and the results, once obtained, are sufficiently outstanding to hold their interest. These experiments thus seem to meet the criteria of introducing reasonably advanced techniques, yielding interesting results, and yet being doable in a reasonable time.

The heat experiments in the second term, on the other hand, we would hope to drop from the schedule, especially if the chemistry course took over all the thermal subject matter. In particular, the calorimetry experiment should be dropped, as the same kind of thing is done with more advanced techniques in CH 122. The mechanical equivalent of heat might be retained since our present equipment gives good results and very clearly demonstrates the equivalence of heat and mechanical work. We would, however, like to see as much time as possible cleared for the electrical, magnetic, and modern physics experiments which come up next.

It is in this area that the greatest improvements can be made. At present we have three very good modern physics experiments -- a measurement of the charge-to-mass ratio of electrons using the Cenco apparatus, a measurement of the first excitation potential (i.e., the position of the first quantized energy level) in mercury by the Franck-Hertz method using the Klinger apparatus, and a measurement of Planck's constant through the photoelectric effect using apparatus developed in the department based on the Leybold photocell. These experiments require a certain amount of effort in setting up and adjustment, employ some reasonably advanced laboratory equipment, and yield results that are both interesting and good. They thus meet the criteria mentioned above and should be retained. We believe, however, that the remaining laboratory time can be better used than in following the program indicated in the attached schedule. Aside from omitting the calorimetry experiment, the spectroscopy experiment on

(6)

the Balmer series in hydrogen should also be omitted since it duplicates a rather advanced spectroscopic work done in the chemistry course. We are trying the omission of the Balmer series experiment this term. The extra work thus provided plus some extra laboratory sessions that will meet the week of April 15 (marked "no laboratory" in the schedule because of the holiday on April 19) are being used to give extra time to a special AC circuits laboratory and an experiment on rectification and amplification with vacuum tubes. This work constitutes our first response to a demand for more training in electronics and includes familiarization with a fairly advanced oscilloscope, an electronic voltmeter, and a signal generator. Further experience in electronics will be gained in the last experiment, in which the properties and functions of semiconductor devices are investigated.

Electronics experiments combine valuable training with the opportunity for the student to make and study a large number of setups on his own, hence we would like to take advantage of this possibility. As usual, the chief limitation is one of time. It is our hope that by clearing less important work out of the schedule, the requisite time can be made available. If enough time can be cleared, we could proceed a step further and have students undertake as laboratory projects the making of their own setups for such experiments as the measurements of excitation potentials, ionization potentials, the electron charge-to-mass ratio, and isotopic abundances rather than using ready-made commercially available equipment. The availability of kits that facilitate the assembly of electrode structures and that provide glass-blowing material for teaching laboratories bring such projects within the limitations of undergraduate work. The next step beyond this is participation by the students in a program, preferably held in the summer, of real research in a faculty member's laboratory. Clearly such emphasis on advanced laboratory work involves a further commitment of time which may not be possible within the framework of the 6-year medical curriculum, but we feel that at least some of the steps outlined above can and should be taken in the interest of serving the third basic need stated at the beginning of this report.

Respectfully submitted,

Bernard Chasen
Dean Edmonds, Chairman
Murray Freed
Herbert Teager

V. Relativity
- A. The Michelson-Morley Experiment
- B. The Galilean and Lorentz Transformations
- C. The Lorentz Contraction and Time Dilation
- D. Relativistic Mass and Energy

VI. Modern Physics
- A. The Electron and Electronics
- B. The Nuclear Atom and Isotopes
- C. The Failure of Classical Physics
  - 1. Black Body Radiation and Planck's Quantum
  - 2. The Photoelectric Effect
  - 3. The Problem of Atomic Spectra
- D. The DeBroglie Relation and the Davisson-Germer Experiment
- E. Atomic Spectra and Quantum Mechanics
  - 1. The Bohr-Sommerfeld Atom
  - 2. Electron Spin and the Periodic Table
  - 3. The Schrodinger Equation
- F. Nuclear Physics
- G. Elementary Particles
- H. The Solid State

Spring Term, 19[illegible]

Textbook: J. C. Slater, "The Development of Physical Theories"

Week of	Chapter	Lecture Subject	Laboratory
Jan. 15	12 13	Review of Optics	No Laboratory
Jan. 22	14 15	Temperature and Heat Thermodynamics	Interference
Jan. 29	15 16	The Gas Laws Kinetic Theory	Calorimetry
Feb. 5	17	Electrostatics Electric Potential	Mechanical Equivalent of Heat
Feb. 12	18	Electric Current Electric Circuits	Ohm's Law
Feb. 19	19	The Magnetic Field	No Laboratory
Feb. 26	20 21	Faraday's Law AC Circuits	RC Circuits
Mar. 1	Midsemester Examination		
Mar. 4	Spring Recess		No Laboratory
Mar. 11	21 22	Electromagnetic Radiation Relativity	e/m for Electrons
Mar. 18	23	The Electron Electronics	Vacuum - Tube Amplifiers
Mar. 25	24	The Atomic Nucleus Rutherford Scattering	The Photoelectric Effect
Apr. 29	Second Hourly Examination		
Apr. 1	25	Black Body Radiation The Photoelectric Effect	The Franck-Hertz Experiment
Apr. 8	26	The DeBroglie Relation Atomic Spectra	Balmer series
Apr. 15	27	Electron Spin The Periodic Table	No Laboratory
Apr. 22	28 29 30	Nuclear Physics Elementary Particles	Semiconductor Diodes and Transistors

PY 121 Course Schedule Fall Term, 1967-68

Text: J. G. Stipe, "The Development of Physical Theories", McGraw-Hill, 1967

Lectures: M W F, 11 - 12, Room 504 CLA

Week of	Text	Lecture Subject	Lab
Sept. 11	Chapter 1	Derivatives and Differentials	No Lab
Sept. 18	Chapter 2	Integral Calculus	Errors and Data Analysis
Sept. 25	Chapter 3	Vectors and Motion in More than One Dimension	Velocity and Acceleration
Oct. 2	Chapter 4	Newton's Second Law of Motion	Projectile Motion
Oct. 9	Chapter 5 (Rev. Sec. 3.7 and 4.9)	Rotational Motion	No Lab
Oct. 16	Chapter 6 Start Chap. 7	Gravitation and Planetary Motion	Moment of Inertia
Oct. 23	Finish Chap.7	Test	Angular Momentum
Oct. 30	Chapter 8	Work and Energy	Work and Energy
Nov. 6	Chapter 9 Chapter 10	Conservation of Energy Exponents, Logarithms, and Differential Equations	Collisions
Nov. 13	Chapter 11 Secs. 1 - 7	Simple Harmonic Motion	Simple Harmonic Motion
Nov. 20	Chapter 11 Sec. 8 - 13 Test	Waves and Wave Motion	No Lab
Nov. 27	Chapter 12	Geometrical Optics	Mirrors and Lenses
Dec. 4	Chapter 13	Physical Optics	Interference and Diffraction
Dec. 11	_____	Review	No Lab

Oxen Fleischman

Professor Fleischman has continued his research on high energy physics on which he spoke to the department colloquium in December. With NSF support he will be participating in the Boulder Summer Institute for Theoretical Physics.

Unfortunately, his course on Advanced Mathematical Physics PY704 could not be offered by Fleischman writes as follows about it:

> "I prepared a course on Lie Groups including their applications to the special functions of mathematical physics as treated in two recent books (1969) by a) Vilenkin and b) Miller, as well as Wigner's classical notes of over a decade ago. I also concentrated on Herman-Weyl's classic book "Group Theory and Quantum Mechanics."
> When only two students registered, the course was cancelled. When I asked the students if they would be interested in directed study with me, if Professor Cohen agreed, they were initially quite impressed. However each of them decided after a few weeks not to continue, even though Professor Cohen had given his O.K.
> The preparation for the course, however, did have the serendipito effect of revitalizing my flagging research interest, by helping me to see that the stumbling block I had run into in the researc program discussed at length in my report for 1967-1968 was a nee for more mathematical knowledge. I have been following this up ever since -- in particular the work of Irving Segal at M.I.T., G. W. Mackey at Harvard, Bergmann and his student Association Professor E. Saletan at Northeastern.
> We have set aup a small group to study C^* algebras and the recent book by Segal and Kunze "Integrals and Operators." Professors Stachel, Shimony (and Joseph Agassi of the Philosoph Department) are involved along with Peter Bombartz of the University of Leyden who has worked under Segal this year. "

During the year Fleischman taught the evening section of Elementary Physics about which he writes as follows:

> "This was the second large lecture class I have taught, and, is the first to non-technical students. Last year, PY111 was primarily biology majors (pre-med), while this year in addition we had 40% of the students as Physical Therapy ma There was no discussion section for the latter course.
> The lessons I learned last year were quite successfully ap with small informal study and/or tutorial groups set up du early part of the term. I was able to break through the that the great majority of students had during the first setting up a pattern for each subject of a)lecture b)home handed in c) homework handed back and discussed in detai

d)short exam. My office hours to see students were all day Monday and Wednesday, and I encouraged them to see me.

This way, with no midterm examination, the students were pressured to digest each subject immediately. I offered a longer makeup exam for students who had missed a few of the short ones.

This was done with a grader who was both slow and to whom it seemed impossible to explain the notion of partial credit --(since he spoke very halting English). I decided to grade all the exams myself, and have the "grader" check off the homework within a day with "effort grades" --2 = tried all the problems assigned, 1 = tried some, 0 = tried none, where "tried" means set it up -- not copied the statement of the problem.

In order to personally see each student, I offered in addition to the written final an oral final -- which would only be used to raise a poor written final grade. Everyone came, and I was able to reach and teach (and perhaps motivate) the majority of the students.

Because physics is an inverted pyramid subject, for those who had done so poorly that they merited only a D, I offered an incomplete with further makeup final to be given during the course of PY106E. Many students were able to learn Newtonian mechanics under this scheme, and to use it in PY106E.

I made at least one error in the latter course -- I gave no written final, and the orals showed a lack of final digestion of electrostatics for perhaps a third of the poorer students."

Professor Franzen has received a NATO fellowship to investigate research in atomic physics in France and Germany during the coming spring period.

He continues on the panel for evaluation of NSF Post-Doctoral Fellowship applicants, by appointment of the National Academy of Sciences. He also continues on the Board of Editors of the Swiss Zeitschrift fur Angewandte Physik und Mathematik, and as a referee for the Physical Review and for Physical Review Letters, as well as research proposals in atomic physics for the NSF.

In December he spoke at the University of Massachusetts (Amherst) Physics Colloquium on "Electron Resonance Scattering from Rare Gases". In April he spoke for the American Physical Society, New England Section, at the University of Connecticut on "Effect of Thermal Velocities or Energy Resolution of Electron Monochrometer".

One of Franzen's students, P. Bruce Newell, received his Ph.D. in April; R. Gupta and P. Hoeperhas almost completed their dissertation research. R. Wenstrup, K. Bernstein and J. Porter have their research now under way with Professor Franzen.

Committees:

CLA Academic Policy Committee
CLA Advisory Committee
Department Graduate Admissions Committee

Stephen G. Hamilton

Early in the year, Professor Hamilton completed his dissertation and he received the Ph. D. in physics at BU in May. He has been appointed Chairman of the Science Department in the Division of General Education, and he has been warmly welcomed to the College of Liberal Arts Physics Department faculty. He taught in the regular sophomore physical science program at DGE, and he offered one of the new freshman seminars throughout the year, devoting his seminar to the cultural relevance of physics.

BU committees:

DGE Curriculum
DGE Centennial
DGE Afro-American
CLA-DGE Liaison
DGE Grading Revision
GRS Masters Program in Afro-American Studies
CLA Dean's Advisory Committee for Selection of DGE Humanities Department Chairman
CLA Dean's Advisory Committee for Selection of Social Sciences Department Chairman
CLA Biology Core Curriculum
University Committee for Pre-Enrollment Program for Afro-American Students
University President's Informal Advisory Group on Afro-American Student Affairs
Convenor, 1st Conference of BU Black Faculty

Meetings:

Panelist, Danforth Foundation Meeting on "Evaluation of Lutheran Campus Ministry on Metro-East Campuses (!)
Antioch College Conference on Science for a Humane Society

Work and Progress:

Professor Hamilton has contracted with Holt-Rinehart-Winston to write a basic physics text for general education and liberal arts students. In addition, he is beginning a new research project in collaboration with Professor Hellman.

Gilbert Hoy

Professor Hoy was invited to lecturer during June at the 1969 International Center for Advanced Studies in Crete, where the principal subject was magnetism.

During the summer of 1968 Hoy worked as a research partidpant in the physics division of the Oak Ridge National Lab. He also attended the Hyperfine Structure and Nuclear Radiation Conference in California.

Teaching:

Three of Professor Hoy's research students obtained their Ph.D. degrees in the past year: Richard Bell, Dennis Hamill, and K.P. Singh. Dr. Singh has continued as post-doctoral Research Associate with Professor Hoy.

Hoy was tutor for Mr. Carl Cohen in undergraduate honors research. Cohen is now a graduate student and research student in physics at Harvard University.

During the year, Professor Hoy continued his weekly seminar in Mössbauer effect physics, involving the entire research group in our solid state laboratory. He has taught our courses in Intermediate Mechanics, Solid State Physics, Symmetry in Solid State Physics, and Undergraduate Statistical Mechanics.

He has also lectured on science at the Heath Elementary School in Brookline.

Committees:

Chairman, Department Committee on Graduate Studies
Chairman, GRS Committee on Student Support

Lectures:

In addition to his lectures in Crete, Professor Hoy gave invited talks at the University of Vermont, University of Wyoming, Cleveland State University, and the Physics Division of the Oak Ridge National Laboratory.

Elliott Krefetz

Professor Krefetz taught Elementary Physics and also the undergraduate course on Electricity and Magnetism. He was strikingly praised by his students for his energy, clarity, and care in his work. He contributed a stimulating essay on the student-teacher interaction to CLAP 2. Krefetz also continued his research in relativity.

Leonard Meyers

During the past year Professor Meyers continued research in low temperature physics; specifically, extensive magnetic flux quantization experiments on small hollow superconducting cylinders of metal films, in collaboration with Robert Meservey of the National Magnet Lab, M.I.T. Some of this work was reported at the American Physical Society meeting at Los Almos, in June.

During the year Professor Meyers taught the basic course on the physical sciences PY101-102 for students not majoring in science as well as the undergraduate Thermodynamics course, primarily for physics majors, concerning the former, Meyers comments as follows:

> "My experience in PY101-102 is difficult to evaluate. I tried to make the course as relevant as I could without compromising the integrity (or self respect) of science. I emphasized development and conflict of basic ideas in the history of science (as an example, we spent a considerable amount of time discussing all the ramifications of the Copernican revolution, social and political as well as scientific).
> With a few exceptions, the class of over 100 students was made up of students from S.E.D. A large number of the students resented having to take a course such as PY101-102 before they entered my class (many of them told me so). They did not see how a course such as Physical Science could be relevant to their lives, either before or after taking the course. Some of these students told me that I did not succeed in communicating with them. Well, that is certainly true for these students, but whether I am responsible, or something else is responsible, I have not succeeded in understanding. I believe that in some of my students hostility to science and mathematics is so deep that no classroom experience could be satisfactory to them. This rather wide spread hostility ought to be a subject of considerable apprehension to people who love science.
> A smaller number of students did enjoy the course and do believe, as well as I can tell, that the history and basic ideas of natural science are relevant to their lives. I have not discovered any obvious differences in the backgrounds of students who liked the course and those who did not."

Paul Roman

Professor Roman continued his research in high energy theoretical physics and elementary particles. During his spring sabbatical leave he had been Visiting Professor at the Institute for Theoretical Physics of the University of Naples.

He was elected a Fellow of the American Physical Society, and a member of the Editorial Board of the International Journal of Theoretical Physics.

His new text and treatise Introduction to Quantum Field Theory was published by John Wiley in March.

During the first semester Professor Roman taught Advanced Mathematical Physics and also he offered the seminar in Theoretical Physics PY 815A on the topic of Current Algebras and them Application to Hadron Physics.

Committees:

Department Committee on Graduate Studies

Abner Shimony

Professor Shimony was invited to speak on "Visions and Revisions" at the Minnesota Conference on Probability and Induction. He also lectured at the Pittsburgh Center for the Philosophy of Science on "Theory, Common Sense and Perception"; and at Case-Western Reserve University where he offered "A Survey of the Measurement Problem in Quantum Mechanics".

Professor Shimony has in progress a book on the conceptual Problems in Quantum Theory. With a graduate student, Michael Horne, he has proposed an experiment to test local hidden variable theories in microphysics, a unique and possibly fundamental development at the foundations of modern physics. With another student, Bror Hultgren, he has begun investigation of ergodic theorems in classical and quantum mechanics; and with Michael Freedman, Shimony has continued his work on information theory and the foundations of statistical mechanics.

Shimony's teaching has continued happily to be split between philosophy and physics. In this department he taught the basic Theoretical Physics course on Classical Mechanics during the fall, and our advanced seminar on Philosophical Foundations of Physics during spring.

Committees:

Chairman, Interdepartmental CLA Committee on the Concentration in Physics and Philosophy

Philosophy Department Personnel Committee

Joshua Shuchatowitz

Report on the Freshman Seminar "Laboratory Seminar in the Laws of Physics and Their Applications" 1968-69.

Description of the Course

The objective of the seminar is to enable students to investigate basic physical laws and to become familiar with the methods and strategies of experimental research. Emphasis was on supervised, but essentially independent work. Student selected, and to a very large extent designed, their own experiments within a specified topic area. They were encouraged not to depend on high-priced ready-made equipment and set "cook-book" experiments.

Course Structure

The course structure consisted of a discussion of a selected topic followed by investigation and hopefully verification of the physical law in the laboratory. At the beginning of the year the experiments were quite ill-defined and frequently did not work too well, but as the term progressed, the students slowly learned reasonable experimental design. The students had been taught to "think like a scientist" and therefore were not afraid to attempt procedures they had never done before as long as the physics was sound. Several students came in many extra hours to do work on their experiments. The students were encouraged to do outside reading in order to understand the experiments. As stated above in the course description, they were encouraged not to depend upon high-priced equipment but to build their own specialized apparatus where possible.

Observations on the Course

1. The course started out with fourteen students and completed the year with thirteen.
2. The average student had little understanding of science and its methods. They were totally unaware of the real world around them.
3.
3. The first two months of the course was essentially an orientation period in nature.
4. Some of the actual experiments included a study of micro waves, polarization, acceleration due to gravity, interference effects, conservation of momentum and energy.
5. The responses to a questionnaire indicated that the students considered this course a real challenge which in most cases was rewarding and worth the extra effort. They indicated that the preparation and report writing usually required more time than their major course of study.
6. The following is a direct quotation from a letter sent by a student at the end of the term:

> My general feeling was that the course dragged for the first 8 weeks or so because it was not structured enough. Feeling for the subject matter came only after that time when I was able to fully adapt to the situation. However, I feel that in these first eight weeks I learned more about physics than I learned from a year course in high school.... All in all, I consider this seminar a valuable experience, and I would not hesitate to recommend this to any one. By next year most of the kinks in the course should be worked out, and it will be a valuable addition to the present curriculum.

Armand Siegel

About his research Professor Siegel writes as follows:

" During the academic year just ended, I brought to a successful conclusion my study of the roots of Classical Statistical Mechanics in Quantum Statistical Mechanics. Since about January this subject came to preoccupy me almost to the exclusion of other fields of research. I expect to spend the next two years focusing my efforts on the task of drawing out the implications of this formulation. The new insights that I hope to gain from this work should be in the field of quantum corrections to the equilibrium statistics of gases, and transport processes in gases.

Work on functional-integral methods of evaluating partition functions and other Wiener integrals has been continuing with Dr. Terence Burke, Research Associate. We have been able to draw together the different kinds of expansions of these functional-integrals found by us and collaborators. We expect to write up this work in definitive form during the summer.

Professor Shigeo Naya of Kwansei Gakuin University, Japan, has been spending the academic year working with me as Visiting Associate Professor, supported by a grant from his University. Starting with a group of incompletely related concepts that I have had on my mind for a number of years, he has arrived at a very satisfying formulation of the perturbation expansion of the partition function of the quantum anharmonic oscillator."

During April, May and part of June Professor Siegel served as Acting Chairman, and he comments as follows:

> "This turned out to be a very satisfying experience, if only because I was able to keep my head above water and derive a feeling that everybody associated with the department felt that things were under control. Perhaps the biggest single help that I received came from none other than the absent Chairman himself who did not cease to interest himself in the affairs of the department simply because he was 3,000 miles away. But I had much help from others, most notably Professors Hoy, Chasan and Zimmerman each of whom handled major areas of departmental affairs. Subtracted from the satisfactions described above must be the anxiety such a task must bring about in an active research worker who has trouble separating his mental functions devoted to research from those devoted to departmental administration. In any case the time spent was quite considerable on the whole even though on occasion a week or two went by with very little to do. The major time-consuming items during this period were the questions of handling Astronomy appointees to the faculty, the litigation involving the concept and appointment of "Lecturers", and the details of the annual Teaching Fellow appointments."

Siegel taught Thermodynamics, Vibrations and Waves, and an honors discussion section of the fourth semester of our two-year course in Principles of Physics for science and engineering majors. About his experience this year, he writes:

> "Although the number of students that I have come in contact with has not provided an entirely adequate sample, I feel aware of a distraughtness on the part of the male students similar to that which Professor George Wald of Harvard has commented on, and which I attribute to the ever-present threat of the draft. In my PY202 Discussion Section, the male students were more disciplined (it was an honors section) but with at least some of them I had the feeling that their intense interest in the course was more due to anxiety lest they fail and endanger themselves, than to love of physics.
>
> All reservations taken into account, I still count myself lucky to be teaching in a field whose relevance is virtually self-evident even though its supposed pretensions to universal applicability have (quite justifiably) come under increasing question by intellectuals in recent years."

Siegel gave the following talks: "Statistical Mechanics as a Deductive Science", paper presented at the Boston Colloquium for the Philosophy of Science, February 13, 1968. (This item was inadvertently omitted in the 1968 report). "Evaluation of the Anharmonic Oscillator Partition Function", Boston College Colloquium, March 26, 1969. "Statistical Mechanics from a Quantum Point of View", Boston University Colloquium, April 23, 1969. "Statistical Mechanics

from a Quantum Point of View", Yeshiva University Conference on Statistical Mechanics, March 31, 1969.

Committees:

Department Comprehensive Examination Committee

John Stachel

Professor Stachel attended the inaugural meeting of the European Physical Society in April where he participated in the discussion on relativity and cosmology. During this trip, which was financially supported by the GRS, he

was able to visit and lecture to relativity research groups in London, Paris, Prague and Florence.

He spent six weeks during the summer of 1968 as Senior Research Investigator in the Temple University research group in Philadelphia, collaborating with Peter Havas.

Stachel was invited to speak at the second Cambridge Conference on Relativity in May (actually held at the Institute for Space Studies). His topic was "Variational Principle and Conservation Laws"in Post-Newtonian Hydrodynamics". He was invited to lecture at the 1969 Enrico Fermi School of Theoretical Physics on "Relativity and Cosmology" at Varenna, Italy.

With support of GRS, Professor Stachel continued to conduct the EU relativity seminars. The programs are listed elsewhere in this report.

Committees:

Chairman, Department Library Committee
Incoming Chairman Department Committee on Graduate Studies

Research Activities:

Two research students have been working with Professor Stachel this year, who reports as follows:

" Mr. Thomas Pascoe, working on problems of relativistic hydrodynamics, has made very good progress and gave a paper at the New York meeting of the American Physical Society based on our work together. It is hoped that he will finish his Thesis work next year, thanks to grants from GRS for this summer, and a NASA Fellowship for the next year, and be able to write up several aspects of the work for publication.

Mr. G. Gonzales-Martin, working on Newtonian approximation methods starting from non-flat background metrics, was able to make a good deal of progress during the first semester, when he was able to devote himself full-time to research work, thanks to research support he was able to get from the physics department. Now that he has gone back to his full-time job at the Cambridge Electric Accelerator (he has a wife and six children to support) his progress is considerably slower; but he has finished enough work to start preparing the first portion for publication. It is also

to be hoped that he will finish next year, but this seems less certain than in the case of Mr. Pascoe."

Professor Stachel's research is well reflected in the list of publications. He has, in addition, some as yet unpublished work on the gravitational analogue of the Aharonov-Bohm effect (on which a number of talks have been given), and on the non-existence of positive mass static solutions to the Einstein equations with point-like singularities.

Teaching:

Professor Stachel conducted one of the three new Sophomore Seminars this year, on Relativity for students with no background, but an interest in the subject. He writes:

"I think the first semester, where we covered special relativity, was rather successful; while the second semester on general relativity was distinctly less good. I will have to rethink my approach to popularizing this subject if I ever give the seminar again. Student interest was good, and the group which started out at about 15, shook down to 8-10 who stayed through to the end, participated in discussions, gave reports, etc. I think the seminars in science can prove most valuable, as much for directing faculty attention to the problems of communicating abstract ideas to a wider audience, as for directing student attention to the importance (hopefully) of these ideas for liberal education.

My graduate Relativity Course in two semesters has benefited, I feel, from some reworking since the first time I gave it. Some students, I have heard indirectly, would like me to cover some more elementary material, perhaps by extending the course to a third semester. This will bear consideration."

J. Gordon Stipe

Professor Stipe spent the academic year 1967-1968 on sabbatical leave, getting a start in a new research field. The first semester of the year's leave was spent at the Lunar and Planetary Laboratory, University of Arizona, Tucson. For the second semester he was based in Boston but took several trips. In 1968-1969 he returned from leave and began work in a field that is new to him and to the department: Solid-earth geophysics, including studies of the interiors and surface features of the earth and other planets and comparative planetology. This is complementary to the geophysics of the upper atmosphere as studies by Professor Papagiannis and his students and is related to studies of the lunar surface by Professor Hawkins and his students.

In October 1968 Professor Stipe spent five days in Valparaiso, Chile, teaching physics in the U.S. Navy "PACE" program. In February 1968, while on sabbatical leave, he made a similar trip to McMurdo Sound, Antarctica, for more than a week.

Professor Stipe has recently been elected Secretary-Treasurer of the New England Section, American Association of Physics Teachers, a post that he held for several years before going on sabbatical leave.

Professor Stipe's book, The Development of Physical Theories, published in 1967 by McGraw-Hill, is used as a text in more than forty colleges and universities.

Committees:

Department Committee on Undergraduate Studies

Charles R. Willis

Professor Willis has continued his research on the interaction of radiation and matter, the results of which have been presented in a series of papers on the Quantum Theory of the Gas Laser, and most recently by two talks during February to the annual meeting of the American Physical Society.

Committees:

Chairman, Department Doctoral
Comprehensive Examination Committee

George O. Zimmerman

Professor Zimmerman was invited to speak at the XIth International Conference on Low Temperature Physics which was held in St. Andrews, Scotland in August. He also has lectured at the University of Minnesota Physics Department in January and at the annual meeting of the American Physical Society in February.

His student, Roy Yee, received his Ph.D. in April. Other students have their research under way; D. Abeshouse, F. Kearly.

Committees:

Chairman, Department Graduate Admissions Committee