Minutes of Meeting 12/10-12/1956 Summary Chairman J. I. Zacharis.

Summary

Minutes of Meeting

12/10-12/1956

Chairman Prof. J. I. Zacharias.

Prof. Zacharias opened the meeting. He stated that groups at MIT, Cornell, Illinois, Cal Tech and Bell Laboratories had been thinking about a possible syllabus for high school teaching of physics. Each group would be called upon to present its syllabus. Discussion should be confined to the content of syllabi, and not wander off to philosophy and phsychology of education. The chairman called on the MIT first. Francis Friedman reported.

Fridman: Our group travelled around the country gathering ideas and enrolling people; it also saw a number of films and other activities.

The MIT outline starts with Optics. Reasons: The main reason is the great richness of simple optical phenomena; they fall into two categories: those that the student has already observed and will then study more deeply, and those that will appeal to him because of their novelty. Another reason is that optics can be done with kinematic description, without much mathematic, and with no dynamics. A last reason is that the wave phenomena have been understressed; the student has been introduced to waves late and has had difficulty to familiarize with them.

The optics section is long: presents phenomena and the undelying picture, giving some idea of how bodies move, thus leading into dynamics. Optics and mechanics will interweave, since from mechanics we would go back to some optical phenomena. Optics may thus take up to one half course. (and mechanics)

From there we would go on to electricity and magnetism . We would often tie back to the previous sections, for instance through the ballistics of charges and bodies. We would also give some idea of field, not in a mathematical sense, but as a property of space. A " Faraday field" Specifically, we think of the Coulomb law and the Lorentz force.

Optics and mechanics will be used to illustrate and emphasize the submicroscopic world. So the first part of optics will be geometric, with emphasis on rectilinear bundles. Reflection will be done briefly. Refraction will be the first subject presented slowly, showing steps, simplification and need for it, application of a phisical law to more complicated phenomena (refraction between two meadia) and total internal reflection.) At first we would give only an empyrical idea of waves. We would go on to lenses as a technological application showing the going back and forth between science and technology. In the film and course there will be only the presentation of how one can arrive at building a lens. The student may be led to do more work on the relation between object, focal point and image in various systems through carefully prepared problems and the student's kit of materials(?)

(The idea of the monograph as a possibility to further subjects was introduced from the floor at this point. Rossi speaking)

Morrison (?)

A discussion on possible type of laboratory work for children followed.

Friedman; The second section of optics would introduce the wave concept and check the phenomena described in the first section, in order to give a deeper interpretation of them. The concept of velocity of propagation, for instance, would be introduced here , and also the concept that something may push waves, without talking of force yet.

N. 3 A more deep review of phenomena and various ways of looking at them. Example: it would be difficult to explain the split up of light into refraction and reflection with the bullet picture while the wave picture fits better both here and in the rectilinear propagation.
Waves: longitudinal, transversal, ripples, strings, acoustical type.

We shall build up concept and properties of waves from macroscopic phenomena which the student can see, and then compare the scale of the light wave with the visible. We shall show this rather in moving than in standing waves. Standing waves through waves reflected back and forth. The film technique will be of great hel p especially in showing interference phenomena

The major emphasis in the whole section on optics will be to build the wave picture and to familiarize the student with it. We may introduce qualitative dynamic concepts

Discussion on the appropriateness of starting with optics

Rabi: You get the information through the visual sense. Phenomena are familiar in a disorderly way. The student learns to order them, learning therefore the scientific method. Then he goes over them to study them more deeply, in a second level of penetration. Example of refraction. The student learns also that the order of phenomena may be immutable but the theory explaining them is not immutable.

Frank (?)

Question. This is an example of the inducive method. The teacher has in mind some conclusion. He makes the path to reach it seem beautifully simple and clear. Only afterwards of the discards the irrelevant... he shows some difficulties This has no relation to science. It is a fraud to pretend anything is discovered this way.

Zacharias The explanation is that you must concentrate in a few hours the presentation of what took centuries to develop.

Friedman Goes on presenting the MIT outline: Mechanics. Emphasis on

Newtonian dynamics: forces used to predict motion, and motion studied to learn about forces. Momentum.

The MIT group feels that some electricity and magnetism must be developed before it may be possible to go into ballistics

The Coulomb law will be presented with pith balls.

The MIT group has not given much thought to electricity and magnetism yet, but is working on the structure of matter (atomistics. (outline attached).

People who have worked on part or all of the outline are: Rossi, Michels, Little, Purcell, Ingard, Gottfried, Osborne.

The chairman calls upon the Cornell group.

Hans Bethe presents the Cornell outline.

He explains that they have diverged from the traditional approach. They had in their group two chemists who proposed a physics-chemistry integrated course of 2 yrs. Since all were atomic scientists in the group, they started with the atomic picture and filled in the classical physics later

Aims: they aimed at students who will not go on with physics and chemistry. May be an obligatory course

The first year is a unit in itself and gives an idea of the world around us. The inductive method is not used here and in this respect Cornell is complementary to MIT. The second year brings in the understanding. This outline introduces student to modern physics. He lives in modern world and therefore should know what is physics now.

The outline presented by Bethe and attached is found very full, more a graduate course than high school course. It is called a "memory course" a statement refuted by Bethe.

Monday afternoon

Wheeler Loomis speaks for the Illinois group. They have not They had syllabi
a syllabus for presentation. Several people wrote first
(in mechanics)
chapters, and they found that in writing they greatly deviated
from syllabi. They want early trial of course on students: as the course
is prepared they would have a high school teacher it use it in the
University high school (the method is currently used to try a course
in mathematics.) As the material is emended and corrected,
tried
it would be .in a public school
He stresses the importance of finding ways of getting students' partici-
pation. They have already given thought and time to this point
and worked out the script of a film on motion.
The Illinois group has started from mechanics,as the place where
more experiments can be made. They would give the minimum necessary
of atomic physics at the end of the course.

Bell Laboratory group

Millman speaking (?)

(Millman speaking [?])

Bell Laboratory Group

Criticizes both MIT for leaving out chemistry entirely and Cornell
for considering only student who will not go on in physics. Goes
on presenting their outline, and pointing out that while some peripheral
parts of physicis do not have to be included, they do not have to be
excluded either. This comment leads Phil Morrison to speak of monographs
Rabi points out that all outline fall short in the education al aim of the
program, of making it possible for non-scientists to talk with scientists
to tie the development of physicis with historical ideas, controversies. etc.

A long discussion followed about coverage versus depth of teaching, time taken by the course, ways of supplementing the course.

The chairman then calld on Cal Tech. Only Whaling present.
Whaling reported that their group would like to see mathematics enphasized; to stress that there is still a lot that is not known and unlikely to become known; and that engineering should not be slighted. Cal Tech is decidedly interested in technology.
A discussion followed in which it was pointed out that some technical applications, like a refrigerator, depend on too many variables to be easily explained, and that a Physicst's explanation of it would be different from an engineer's
Stephen White the told his experience as a journalist assigned to report in science; when he had to learn about science he receive intellectual stimulation, learned about methods etc.. The cultural aspect is much more important than the coverage and the choice of the subject should be subordinate to the cultural aspect
There followed a discussion on the motivation. The course should be planned so as to provide the student with a motivation

Dicember 11 - Morning

Rabi exposed his ideas on teaching methods by on the example of utilize the refraction law. He would make use of film strips for the demonstration; he would show the progress in refraction step by step, repeating measurements with increasing accuracy. Would make historical references; show the diagrams and how to use them; look for simplicity; try a few function; arrive at the refraction index.

A discussion followed; the education of teachers through summer programs; the iathus in the mind of the child between the ray of light and its representation by a line drawn on paper; the question of new nomenclature and definitions, were mentioned.

The Steps in the teaching method started to be enumerated enumerated:

1 Regularities

2 Model

3 Extendion of regularities to generalisation

4 extrapolation

(these were called "acts of faith")

A discussion on "precision" and the lack of it, its importance etc.. followed

A discussion on data, movies, tabulation and stroboscope.

Limitations of laws

Solidity of physics (limits of model: they must be shown as a caution, but not give the idea that scientists do not know what they are doing)

The chairman stated the need for clarification of the following points

2 yr or 1 yr course — chemistry
2 approaches — physics

Points of agreement

Inclusions and exclusions; on what grounds.

The jobs to be done: what, who, when.

Bethe stated that to accomodate the development of scientific thought in the course some subject matter must be sacrificed.

He enumerated other points in the teaching method:

Unity of physical science (If it not possible to cover many subjects in depth, some must be included not in depth)

Some subject matter is important. The atomic picture is important

Discussion on the advantages of teaching physics or chemistry first

Solidity of science: many different arguments for one law.

Deduction of phenomena from law

Emphasis on mathematics

Controvery and present times conflicts

Changes in physics: new models include old; old models in small areas.

Discussion on the integration of chemistry and physics in a two year course.

Bowers: there are three concpt to be sold in chemistry:

matter has structure

the structure can be changed through chemical reactions - laws ruling reactions; notion of law; dynamic equilibrium

rates of reaction - temperature is one factor

We work in a vacuum if we pretend that the structure of matter has no influence on properties

Rabi presents four reasons against the integration of chemistry and physics

Discussion whether physics of chemistry should be taught first

Agreement: physics should be taught first; however, it requires more mathematic and it may be necessary to teach it only in the 12th grade

Bowers proceeds in showing the need of physics in chemistry, on the example of vapor pressure

Question whether the discussion of vapor pressure as given by Bowers is ~~readily~~ posssible at high school level

Discussion on how much students knew before taking th physical science course in high school

Mass spectrograph should be in all schools these days. A simple one.

The need for points of agreement in order to be able to do the work.

If a few points of agreement were found now, there could be another meeting in 6 or 8 weeks.

MIT group could continuo with optics worrying about:

syllabus

draft of texts

film treatment

trial movie

at the same time there should be interaction with high school people

Chauncey Need for evaluation of texts. The people who are doing the work should write questions for the exams Through the exams you find out what you have accomplished. Test questions can be devised that will tell:

ability to identify and delimit a problem
to suggest or recognize hypothesis
to select procedures
to collect data
to recognize or formulate valid conclusions
to apply law to familiar and unfamiliar situations
to recognize cause and effect relations .... etc.

Discussion on evaluation and testing-on-student methods

The need for cooperation with high school teachers stressed again

Need for a statement that the physics presented eventually by this group is not necessarily the only type of physics.

Statement: it is not important to decide what percentage of high school students we address. Rather do our best, and then, through testing, find out how many we have reached.

Discussion on the size of the ~~xxxx~~ student population we aim at : 20 or 70 % ; those who will go on in physics or those who will not?

Zacharias: Let~~s~~ us aim at 25%, the ones taking physics in high school now.

Bethe: the only important thing is to know that we are not aiming at 100%

Brandwine: if we aim at 25% the question of how much mathematics the has
student had, becomes unimportant . It can be refreshed ~~xxx~~ as needed

The chairman at this point made an attempt at defining the points of agreement starting from the Cornell outline, because this was the most complete. In substance, the meeting came to devide the matter in the outline into two headings: one, subjects that would be included if the course were a 1 yr course; two subjects included in a two yr course. The material that would go in the course only in the case in which this would extend over two years was mostly chemistry.