A Glimpse of PHYSICS TEACHING EQUIPMENT at the University of Moscow

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WE all have an inherent distrust for a traveler who spends ten days in a country and thereafter poses as an expert on all phases of the country he so briefly visited. However, since I have been concerned with undergraduate physics education both here and abroad for some time,* my impressions of the methods of the University of Moscow in this area may be of more than casual interest. This report is based on my own observations and on the answers to many questions which I had the opportunity to ask both of students and teachers during the recent Second All-Union Conference on Gaseous Electronics held in Moscow from October 1 to October 13.

Although secondary-school education is carried out over a ten-year period in the USSR, their pupils start this education later than ours do in this country. Students, therefore, arrive at the college years at about the same age, averaging 17 for the entering class. The total undergraduate physics course covers five and one-half years, the first two years of which have a common curriculum for all those in physics independent of their specific desires. In the third year a certain amount of flexibility is introduced, and during the last two years the students become specialists. The total amount of instructional time in physics is set at 6000 hours, and for this there are 30 lecturers and 33 laboratory instructors, as well as the rest of the 250 teachers in the Physics Department who have student contact through seminars.

This year there are 423 physics students in the University. Elementary physics classes are conducted in three lecture halls, of which the largest holds 530 students and two others 350 students each. These are connected by a long room for preparing demonstration apparatus and for storage. Their apparatus supply boasts of fifteen hundred pieces of demonstration equipment. The lecture hall is under the control of the Physics Department and is free for two hours before each lecture to allow for preparation of demonstrations by technical personnel. The lecturer spends half an hour in the lecture room to make sure that everything is in order. The acoustics of the auditoria are very good. They need no microphone for lecture demonstrations but the lectures are transmitted to other rooms for recording and rebroadcasting if necessary. The demonstration apparatus is characterized by excellence in workmanship. Many demonstration pieces are carried over from the German school of instruction, much as is our older equipment. They have succeeded perhaps better than have most of our lecture apparatus manufacturers in building their equipment big enough, and one of the outstanding features of even the more standard pieces of equipment is their very large size for demonstration use.

I went through their undergraduate laboratories in careful detail and was impressed by the quantity as well as by the quality of their laboratory instruction. In both the first and second years at the University the students have one six-hour laboratory period per week. In these two years they perform 45 or 46 experiments per year. In the third year they must spend 108 hours per semester doing 30 experiments or less. These third-year laboratories are unscheduled except for equipment competition. At each level experiments are assigned one week in advance, and the instructor discusses the theory of the experiment with each individual student for about fifteen minutes at the beginning of every period. This is possible because the student-instructor ratio averages about 8 to 1. The experiments are corrected by the instructor in the presence of the student, a process which usually takes five to ten minutes. A student who misses an experiment must make it up.

There is considerable emphasis on practical technology, and beside their work in the laboratory, many of the students are required to work in factories in Moscow and its environs. This depends somewhat on the course interest of the student; but, for example, in the field of electron physics and radio physics the students spend a total of 288 hours in factory work in addition to the laboratory work in the University.

The first year's experiments lie in mechanics and atomic physics, and the second year deals with electricity, magnetism, optics, and modern physics. Third-year students may choose a specialty if they want to do so, but in the fourth year they must concentrate on one of the following: nuclear physics, solid state, optics and spectroscopy, molecular physics, theoretical physics and mathematics, low-temperature physics, gyrophysics, astronomy, radio and electricity, or electron physics. In the third year there is a considerable emphasis on electronics and electrical cir-

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cuits. The student wires an amplifier or oscillator starting with a sheet of aluminum. He must bend this into a box for a chassis, rivet it together, punch all the holes, put in the sockets, and then proceed to wire up the device he has chosen to construct.

In the fourth year the students either stay at the University for their experimental work or go to other institutes in Moscow. These institutes are research laboratories divided by subject, whose staffs have appointments at the University but often teach no courses. They act as research directors accepting students and supervising the work required for a diploma in a specific field of research. The institutes which had third, fourth, and fifth year students in my own particular field of gas discharges include the Institute of Atomic Energy, the Moscow Power Institute, the Institute for High-Voltage Physics, and the Institute of Nuclear Research at Dubna. Students who do well in their work as undergraduates in these institutes often stay on as employees and become aspirants for the degree of candidate of science, equivalent to our PhD.

The undergraduate laboratories at the University are tremendously full of equipment. Of the 25 to 30 laboratories I went through in detail, more than half were so crowded that one had to walk sideways between the laboratory tables and the apparatus or else one could not circulate completely around the room because apparatus blocked the free passage of people from one end of the room to the other.

In general, there are two or three pieces of apparatus more or less permanently set up for each experiment, and the student moves from one experiment to another in rooms specifically assigned for related groups of experiments.

With a six-hour laboratory period every week, the experiments range from the very standard and somewhat humdrum experiments which one finds in almost every physics laboratory in the world to some very imaginative experiments. At MIT we have been reorganizing our laboratories for the last five or six years and feel that we have some very excellent and thought-provoking experiments. My impression of these laboratories at Moscow is that they have progressed much as MIT has, aiming many of their experiments at the same kind of imaginative thinking, but that they have not sloughed off the older and more routine types of experiments. They have so much time available that they can include both the 1890 and the 1959 varieties. Their electronic equipment is very much like ours. In fact, most of their test equipment, such as oscilloscopes, seems to be copied from equipment in this country. On the other hand, the optical equipment and the spectroscopic equipment used routinely in the third-year laboratory would make any research laboratory in our big universities envious. Although the laboratory rooms were jammed with apparatus, they did not seem to be crowded with students. Instructors were always available in every room, and the number of students varied from two to about fifteen.

I toured the Physics Department several times, both on official tours run for visiting physicists from other parts of the Soviet Union, and unofficial visits escorted by the three physics student interpreters who had been put at my disposal by the University. It was obvious from the interest and questions from other Soviet teachers on the official tours that Moscow University is not typical of most other universities in the USSR. I gathered that the other universities look on the University of Moscow as the MIT of the Soviet Union. My student guides told me that the universities at Leningrad and Kharkov have the same standing as Moscow, but these three lead the Soviet Union in physics education.

Undergraduates Tolya Shahad and Gil Pontecorvo examine a spectral plate in their third-year laboratory at the University of Moscow.