

ALMOST APPARATUS.

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I don't think that I have ever recovered from a disappointment which I suffered in my boyhood. The advertisement of a telescope, which I had seen in some more or less reliable journal, was the cause of the trouble. The description was so suggestive and the accompanying picture so attractive that I felt that if only it were possible for me to possess such a beautiful instrument, the world would be mine forever. At last my grandfather sent for this unusually valuable scientific article, and when the package arrived he presented it to me with due ceremony.

To my first glance that telescope looked just like the picture, but soon I began to discover some differences. The first thing I noticed was a flaw in the brass cap at the small end, then the sliding tubes were only too evidently constructed from brown paper, and finally I found that after very careful focussing, by holding the eye in a very definite position, and by keeping the telescope very steady, I could see the trees across the fields almost as clearly as I could without the coveted instrument.

With such is science too frequently aided (?). The evil done in this way in many secondary schools and small colleges is probably greater than that wrought by the over-expensive unnecessary apparatus of a few institutions where ideas of experimental physics are illustrated by impressive nickelled and lacquered whatnots in dustproof cases. But this is another story. The work with the hopelessly inadequate and flimsily constructed appliances is generally worse than none at all. -

There always will be, I hope, boys with a type of constructive ability sufficient to solve experimental difficulties with the crudest sort of apparatus. They are, however, so few in number that they may be omitted from consideration here, and anyway it is hardly right to handicap these few by over-emphasizing the wrong thing. Neither would one wish to present experiments in which there were no difficulties. Such would afford no opportunity for developing the mind of the student along some very desirable lines, and would, after all, give no true conception of the reality.

The purpose of laboratory instruction is primarily to give the student first-hand knowledge and acquaintance with phenomena, the qualitative view, and then to enable him to determine the magnitude or quantitative value of what he has seen. Acquain-

tance without measurement is often misleading, and tends to superficiality, already too prominent in circles wider than those drawn about educational institutions. The student should expect to see what he is looking for, not merely to get a glimpse, but to identify in some manner such as measurement affords. Not until he has done this can he truly say that he has conducted an experiment. If the performance can not be repeated with practically the same result, naturally he gets little or no benefit from the laboratory.

The conclusion is then that no apparatus should be put into the hands of elementary students unless it will meet these requirements of laboratory instruction. Such a test would doubtless put a great deal of well-advertised so-called apparatus on the back shelves, where it belongs. However, a further criterion is necessary, and this of a most practical nature. Teachers who handle large classes find it continually advisable to caution students to use great care in handling even some of the most simple pieces, and with all this expect each year no inconsiderable crop of breakages. There is a point beyond which cheapness is no longer a virtue. Apparatus which will not stand up with real use is dear at any price. A laboratory should give the students every opportunity for handling instruments and observing their construction and operation. If it is necessary to curtail this opportunity in order to prolong the life of the apparatus, the instruction is faulty.

It may emphasize the point if I cite a few definite cases. Take, for example, the very common and invaluable thirty centimeter ruler. An examination of a number of rulers showed several with errors as large as five millimeters in the whole length, and edges which were very far from giving the shortest distance between the end points. A millimeter division in one part of the scale might be nearly twice as long as one at another point. Yet we claim that the measurement of length is one of the most accurate possible, and frequently call for measurements to tenths of a millimeter!

Spring balances come in for no little criticism, as the weighing of the same object on several of the cheaper balances will testify. Yet it is possible to obtain satisfactory balances at a reasonable price. Galvanometers seem to have received from the manufacturers of elementary apparatus a great deal of attention of a doubtful character. It is now possible, I am told, to purchase one of the moving coil type, new, for less than \$2.00. To a

school board or purchasing agent all galvanometers may look alike, but the man who uses them will distinguish between galvanometers and "junk."

The equipment for experiments with mirrors and lenses is in many places a source of more annoyance than profit. One teacher recently stated that students could get quite good results with a few blocks on a table, and wax with which to fasten lenses and screens to the blocks. A meter stick made the outfit complete. Simple as it is, this is far better than much of the more elaborate devices I have seen. However, I can hardly agree that this is all that is desirable or even necessary. Good apparatus commands respect, and never have I seen a better illustration than in the case I mention below.

A few years ago our equipment for optical benches was rapidly becoming useless, through breakage, repeated bending, and various ill-advised attempts to use pieces as the maker never expected that they would be used. There was no suitable apparatus on the market at a price which we could pay, so with the aid of our mechanic and the co-operation of a colleague I built a bench with fittings which seemed to meet all our requirements. There was nothing new or startling about the outfit, it was not expensive, and it would stand any amount of use. The first class had not finished their experiments with the bench before students began to ask where they could purchase such an outfit for use at home. We were fairly compelled to go to an apparatus firm and ask them to manufacture this equipment. Since then there has not been a class in which some men did not purchase benches on which they could continue experiments at their leisure.

I hold no brief for the apparatus firm. I have already spent more time in persuading them to make the bench than they would be willing to pay for. But my point is that the students recognized that the outfit was worth while. And so it is with the other experimental work. The equipment for which apology is necessary, which demands unceasing attention to avoid errors in manipulation, will always hold the mind of the student on the wrong thing, and in the end serves only to permit the statement that the student has spent so many hours in the laboratory, and has performed so many "experiments."

Where the fault lies I do not know. Manufacturers will probably never refuse to make stuff which looks as well as apparatus in a catalogue, so long as individuals will spend money for it;

teachers will probably always attempt to equip their laboratories with the appropriations set aside for that purpose; school authorities will probably be as generous as the taxpayers will permit; and few people wish to increase the tax rate. Yet somewhere along the line there should be men and women of force and determination who will not allow the further existence of "almost apparatus."

Q.: How can the acoustics of a hall be improved?

A.: By having a slightly doomed ceiling.

Q.: How do the air particles move during the passage of sound?

A.: The air particles move back "and forth."

THE TESTING OF RUBBER GOODS.

The Bureau of Standards, Department of Commerce, is about to issue the third edition of a circular on the testing of rubber goods. This publication which has been very much enlarged is fully illustrated and describes in detail the method of procedure in conducting physical and chemical tests of rubber. The testing machines and apparatus developed at the Bureau of Standards greatly facilitate the testing of rubber and the object of this circular is to assist manufacturers and consumers in establishing standard specifications and standard methods of test. The subject matter proper is introduced by a brief outline of the processes through which rubber passes before reaching the factory, followed by a short description of the usual processes of manufacture, which include washing, drying, compounding, "making up" various articles, and vulcanizing. The physical tests most commonly employed are explained very thoroughly. These include tests for tensile strength, ultimate elongation and elasticity. Conditions affecting the results of tests are discussed at some length and experimental data are given to show the necessity of a standard procedure in testing.

A general discussion of the chemistry of rubber is followed by a brief explanation of the object of each of the analytical determinations that are commonly made. After this there are given in detail the methods in use at the Bureau for each of these determinations. They are not entirely original, but have been compiled from the various publications on rubber analysis, from the information gained through the routine testing of rubber goods for delivery on Government contracts, and from co-operative research with various scientific organizations.

The tentative method of analysis and specifications for thirty per cent Hevea insulation compounds, adopted by the joint Rubber Insulation Committee, are next given:

A bibliography listing the more important books and journals devoted to rubber, and the Bureau's regulations regarding the testing of rubber goods conclude the circular.

Copies of the publication, *Circular No. 38*, may be obtained by interested parties upon application to the Bureau of Standards, Washington, D. C.