through the surrounding chamber, when the mixture is drawn up and carried away by the current. A similar method has proved most useful in dredging, and even a bottom of hardpan has yielded to the force of the inrushing water, and gravel and rock been sent rattling out through the tube.

In certain smelting operations, where the fumes are unhealthful, a suction placed instead of a blast has been found to remove all traces of the noxious gases. With the blast every little hole is an outlet for the gas, but with the suction the holes become harmless because of induced currents entering them.

When the hand is held near a stream of water flowing from a faucet, wind will be distinctly felt. The volume and force of this wind depend upon the volume and velocity of the water. A sluggish stream will produce no motion of the air that can be felt, but the same stream tumbling over a fall will create a gale. More than fifty years ago this fact was made use of by a mechanic residing in Watertown, this State. He constructed a box which he placed in front of the falls, as near the water as possible, leaving the side next the water open. This was connected at the bottom to a roughly-made wooden box, through which the current of air was led some distance to his shop where it furnished all the blast required by the forge. One of the schemes for utilizing a part of the enormous energy now wasting over Niagara is identical with the above. The measure of this force can be appreciated by those of our readers who have been near enough to the descending torrent to feel its influence.

One of the most characteristic features of the induced current is the apparent increase of power resulting from its use. With the hand held in front of the tube first mentioned the force is considerable, but if the hand be held the same distance from the mouth, say three inches, the expelled breath strikes it with a slightly greater force. The difference is caused by the friction in going through the tube, the effort to draw in the outer air, and the loss of particles of air which do not enter the tube.

AMERICAN ASTRONOMICAL SOCIETY.

At the June meeting of the American Astronomical Society, held at the Packer Institute, Brooklyn, June 4, the subject of the "Fuel of the Sun" was discussed for the second time. Professor Young, of Princeton, opening the discussion, said that to account for the heat of the sun there might be some truth in Helmholtz's notion that the sun is fed on its way through space with meteors attracted to it by its immense mass.

If this theory were true, then the earth ought to get as much heat from shooting stars as from the sun, and the surface of this globe would have three tons of meteoric matter to the square mile. Yet in some way this objection could be explained away. If we are to suppose that heat is derived from matter distributed through space, we should first remember that the matter would make itself felt on the planets of the solar system. Professor Proctor must be wrong in saying this does not necessarily follow. Another thing: if, as some suppose, a current of meteors toward the sun existed, then mischief would be played with comets. They would encounter resistance. Then, too, the temperature of the sun would not be hotter from such meteoric combustion than the carbon points in the electric light.

Professor Young had always supposed that the heat in the sun was not less than 10,000 degrees Centigrade. Yet, as a very slight increase of heat produces an immense increase of radiation, the heat of the sun might be lower than he had supposed; yet he could not believe it as low as that of an electric light. Another puzzling theory had been proposed, viz., that the sun sends its heat only to that which receives it, only to each of the planets, while space outside of a direct line from the sun to the planet remains cold. The idea being that the heat action between sun and planet was reciprocal like that of gravitation. The trouble with that theory was that heat must radiate on all sides, not in one direction only. Finally, there was a theory that solar heat was due to the contraction of the sun's body; the objection to the theory was that it put a limit to the universe. If it is a true hypothesis, then the sun could not be more than 15,000,000 years old, and it could not continue to give heat more than 15,000,000 years more. Such a limitation is not to be thought of.

The subject was further discussed by Mr. S. V. White, president of the society, Mr. G. P. Serviss, secretary, Professors Stevens, Levison, and Parkhurst, Mr. G. D. Hiscox, and other members of the society. The subject selected for discussion at the October meeting is the moon.

THE FRENCH PHYSICAL LABORATORIES.

It is within the memory of many now living that the first laboratory for the instruction of students in the science and art of chemistry was instituted by the celebrated Liebig, at Giessen. Previous to that time most of the chemical work and investigations had been done either in the back room of an apothecary shop or in the kitchen of some enthusiastic preacher like Priestley. The late Professor Woehler gave an interesting account of how he pursued the study of chemistry with the famous Berzelius in Sweden, and of how the faithful Anna washed dishes in one end of the room, while master and pupil solved the mysteries of nature in the other end of the same room. Probably the laboratory of this immortal Swede differed but little from the ordinary wash kitchen of to-day.

For many years American students, beginning with the now venerable James C. Booth, president of the American Chemical Society, flocked to the laboratory of Wöehler to obtain what they could not get on this side of the Atlantic, practical instruction in chemistry. Then came Bunsen and Kolbe, Kekule and Hofmann, and now Fittig and Meyer, with a host of others, who open their willing doors to American students. But the day is passed when chemical students are obliged to cross the ocean. Nine years ago a chemical laboratory was opened in this city where analysis was taught and practiced, and six or seven years ago a laboratory for research, equal to any in Europe, was opened in Baltimore. To-day no institution worthy the name of college lacks a chemical laboratory of some sort.

Why has chemistry enjoyed such an advantage over physics? About ten years ago Professor Pickering established the first working physical laboratory for purposes of instruction in the Institute of Technology, in Boston, and at a little later date Professor Mayer did the same at Hoboken. Now most of the larger cities, excepting New York, have a well equipped physical laboratory. Probably the best equipped of these is the one in Johns Hopkins University, but a new one is to be built in Cambridge soon, and we shall be disappointed if Professor Trowbridge does not make it the best in the world.

In Germany the Professor is more thought of than his laboratory, but where the former is excellent the latter is rarely poor. At present, Professor Kohlrausch, at Wurzburg, and Professor Helmholtz, in Berlin, seem to be the favorites with our countrymen.

The object to be attained by a course of instruction in physics is twofold: First, to obtain a thorough knowledge of the laws that govern matter and force; and an understanding of the action of heat, light, and electricity upon matter. Secondly, to acquire the power of investigating these properties and discovering new laws. It is unnecessary to say that a person should be familiar with known facts and laws before attempting to discover new ones. The former may be accomplished more or less perfectly by reading books and hearing lectures; the latter involves actual work; but we believe that the former is best accomplished by actual contact with the things themselves, so that their properties and relations may become familiar as solid, first-hand mental acquisitions, for this trains the judgment as well as develops the power of *correct* observation. This is not the opinion of all educators, for Prof. T. C. Mendenhall says that he "would relegate to the lecture table of the instructor all illustrative experiments and qualitative work necessary to a good understanding of the underlying principles of the subject, which every student should possess when he enters the laboratory."

Without venturing to differ with so distinguished an authority we still think that the majority of college students and others, especially those that do not intend to devote their lives to the pursuit of this science, but to become teachers, chemists, engineers, architects, inventors, etc., may derive much benefit from a course of practical instruction. What if the crude experiments of the student do seem to disprove the law that he was expected to establish? It leads him to take into consideration the secondary causes and conditions, and to make due allowance for errors of experiments. It were well for the business man, still more for a scientific man, to learn to distrust the adage that "seeing is believing."

In all the walks of life effects are traced to the wrong causes for want of the power or habit of making allowance for secondary causes. Charlatans would find their tricks exposed, mysterious sights and sounds lose their mystery, were people more capable of drawing correct conclusions from their observations. Wonder workers now excite the admiration only of the ignorant masses, but lawyers, politicians, and theologians impose upon the better educated, and scheming financiers, Keely-motor men, and pseudo-scientists succeed in robbing men of high intelligence, while we all yield our bodies and our purses to quacks and other doctors of medicine. In proportion to our ignorance of a subject is our danger of being duped by those skilled in its mysteries.

But to return to our laboratory; while the student should not be expected to rediscover for himself the principles of physical science, he may be allowed to verify these laws by measurements and determinations of his own until he *feels* rather than *thinks* these laws are true. And while doing this he has learned his own personal coefficient of error and is gradually reducing it to a reasonable limit.

Having given our views, the results of much observation and study, as to what can be done in a physical laboratory, without, however, claiming for them any originality, we will conclude with a brief description of the physical laboratory under the direction of Professor Desain in the Sorbonne, Paris.

At the time of our visit it occupied a number of separate and distinct rooms scattered about in the old buildings that constitute a portion of that venerable institution. In each room was from one to three pieces of apparatus. Near each there hung, in a little frame, brief directions in French for performing a given experiment, and formula for calculating the results. The experiments were usually such as could be satisfactorily performed in two hours, and the sessions were limited to that time—10 to 12 A.M. Professor Desain and several assistants were then on hand to give advice, explain difficulties, and offer suggestions.

The following is an incomplete list of principal experiments to be performed, but this particular order was not insisted upon, as no two men could use the same instrument the same day, and each important piece of apparatus was usually engaged a week in advance. Of course a person experimenting with light was expected to finish that before taking up electricity, or *vice versa*, but when sunlight was required, of course the clerk of the weather had to be consulted.

1. Making and graduating thermometers.
2. Estimating the density of a vapor, by Dumas's method.
3. Measuring the magnifying power of microscopes.
4. Measuring the length of waves of light by Fresnel's mirrors.
5. Ditto with Newton's rings viewed obliquely.
6. Ditto, viewed perpendicularly.
7. Ditto, with Billet's demi-lenses.
8. Ditto, with a diffraction spectrum.
9. Use of Norremberg's polarizing apparatus.
10. Use of Biot's rings.
11. Use of Babinet's compensator.
12. Use of Hoffman's polarizing microscpe.
13. Circular polarization. Biot's laws verified.
14. Jellett's apparatus.
15. Measuring the rotatory power of quartz crystals.
16. Soleil's saccharimeter.
17. Laurent's saccharimeter.
18. Reflection from metals, Jamin's apparatus.
19. Index of refraction measured with a prism.
20. Ditto, by interference, Jamin's mirrors.
21. Calorific spectrum of the sun.
24. Absorption of heat.
23. Polarization of heat, and law of Malus.
22. Use of Melloui's apparatus.
25. Reflection of heat.
26. Internal resistance of batteries.
27. Resistance of wires, Wheatstone's bridge.
28. Measurement of electromotive force.
29. Measuring the horizontal component of the earth's magnetism. M. T.

It will be noticed that the experiments upon heat and light were numerous and exhaustive, this laboratory being particularly well equipped with excellent apparatus for that purpose. In certain other laboratories, where these receive less attention, electricity and magnetism are better represented.

On the whole, we cannot refrain from saying that a course of experimental physics under Professor Desain well repays the time it takes, while his kindness compensates for his ignorance of our tongue. E. J. H.

ROUND NOSES VS. DIAMOND SHAPE.

Unlike most mechanics, the machinist has a liberty of individual expression, one that is not shared by mechanics generally. It is shown in his selection and origination of shapes for tools. And yet there is no department of mechanics where so much of system and absolute rule exists as in that of the machinist; the reproduction of the same sort of machine tools and the duplicating of the same styles of producing machinery is the main object of the machine shop. The production of uniformity in the parts of machines, which is gradually extending, demands absolute system in many of the tools used— system as to form, size, material, and methods of operating. Yet with all this tendency to uniformity the machinist is largely independent in his selection of forms of bench, lathe, and planer tools. Adopted shapes of tools, which are not necessarily determined by gauge, have not been successfully introduced into any shops. Attempts have been made, in some instances, to designate the style of lathe turning tools and planing cutters for certain purposes, as roughing and finishing, which do not necessitate gauge exactness. But, even if the tool-forger works to any prescribed pattern, the tool-user can change its characteristics at the grind-stone; a right of which he is not slow to avail himself.

In the use of interchangeable lathe and planer tools—stock and bit, instead of solid tool—there has been a pressure, in some instances, to substitute a round-nosed cutter for the diamond point for roughing up and also for finishing. It would be difficult to convince any machinist, not educated to the round-nosed tool, to believe that it will do the work as rapidly and as well as the ordinary diamond point does. Different workmen have their different shapes for the diamond point. Most experienced machinists insist upon having the innermost cutting point—that which reaches nearest the center of the work—somewhat higher or more projecting than the after-cut portion. Then there are others who insist that a level top to the tool is the best, but one of the most experienced workmen, with many years of practice to draw from, insists that the point of the turning tool—the diamond point—shall be the lowest of any cutting portion, and illustrates it by a pocket knife and a round stick to prove that the cutting of the iron should not be a wedging and gouging out of the material, but a shaving of it off from the core by such a shape of the tool as to insure a drawing cut.

It would be difficult, even after experimental tests, to decide upon any one particular form for these tools, so much depends upon the user, the workman. One man will turn out a large amount of excellent work with a tool that another would condemn as almost useless; so, although the practice may be indulging "quirks" and fancies, it is probably good policy to allow freedom to the workman in this respect, so long as it does not degenerate into costly experimental folly.