Municipal Chemistry. A series of thirty lectures by experts on the applications of the principles of chemistry to the city, delivered at the College of the City of New York, 1910. Edited by CHARLES BASKERVILLE, Ph.D., F.C.S. New York, McGraw-Hill Book Company. 1911. Pp. 526. $5.00 net.

The title of this book is sufficiently suggestive of its intended scope. The lectures here brought together in printed form were given before the student body of the College of the City of New York in the spring of 1910 and were open to the public. The interest they aroused was taken as sufficient to warrant the publication for a larger audience.

Chemistry plays a very important and ever-widening part in the affairs of life, and especially of the life as it is lived in a great city. Problems of food supply and preservation, of pure water and disposal of sewage, of garbage cremation and smoke prevention, and a dozen more which might be easily mentioned, call for the aid of the chemist in some direction. It is proper to present to young people in college the conception of the chemist as a man who can do things which the city needs, and on a broad scale. The chemical problems of the city are not merely those of routine analysis, although many analyses may be necessary in their solution.

The men selected by Professor Baskerville to deliver the course of lectures are, for the greater part, well known authorities in their several specialties, and while some of the topics discussed bear but a remote relation to questions of municipal chemistry, in the narrower sense, it must be admitted that they are all of interest at the present time. The editor contributes a good introductory lecture. The papers by Professor Mason on the relations of drinking water to disease and on the purification of water; by Mr. Flinn, of the New York Board of Water Supply, on the water problem in that city and the work in the Catskill Mountains; and by Professor Winslow on the disposal of sewage are perhaps the most interesting in the book. The discussion of the city milk supply problem by Dr. Darlington is also timely and quite worth reading.

In addition to these topics there are lectures on food and drug adulteration, on illuminating gas, smoke prevention, ventilation, explosives, paints, corrosion of metals, cements, road building, textiles, parks and playgrounds. It will be seen that a wide range of topics is covered, and in general in a way to interest young people. The whole presentation is naturally elementary and not of a character to appeal to specialists. In fact, the moderately informed man will recognize most of the discussions as old friends with which he is already familiar. But the book is not intended for the well informed but for those who need and are seeking general practical information. From this point of view it merits a cordial reception.

J. H. LONG

SPECIAL ARTICLES

EXPERIENCES WITH THE GRADING SYSTEM OF THE UNIVERSITY OF MISSOURI[1]

WHY should there be uniformity of grading in an educational institution? somebody might ask. If different grades were simply means of giving some students notoriety above others, the question would be immaterial, for a gentleman does not seek notoriety. But the grade has in more than one sense a cash value, and if there is no uniformity of grading in an institution, this means directly that values are stolen from some and undeservedly presented to others.

The result is that, among the members of the faculty as well as among the students, men look at each other with suspicion. That this attitude is detrimental to the feeling of unity, to the development of a college spirit, is clear to even the most superficial observer. Whatever contributes to a greater uniformity of grading, contributes directly towards more peace, a better mutual understanding, a greater community of purpose among all the members of the institution.

Whoever admits the fact just stated will find much encouragement in the present

[1] Read before Section L of the American Association for the Advancement of Science at the Minneapolis meeting.

status of grading in the University of Missouri, compared with that of three years ago. At that time the university had the traditional marking system based on percentages of an ideal maximum accomplishment, called "100." There would be no objection to this system if all the grading in the institution were done by a single instructor. Experience teaches that different instructors even in the same subject have very different conceptions of what this ideal maximum accomplishment "100" really is.

Among teachers of different subjects this difference of conceiving the maximum accomplishment becomes enormous. There can be then no uniformity of grading, and all the evils resulting from this condition find an open door. Three years ago the diversity of grading had reached such a degree that the faculty took a radical step, abolished the antiquated system and introduced the grading by rank. This does not mean that the teacher is in any way interfered with if he uses, for his private purposes, the marking by percentages of his ideal maximum accomplishment. But the institution no longer accepts such percentages for its official records. Instead the institution requires each teacher to report for each student his estimated rank among a hundred students. This method is a little complex on account of the hundred different grades. To simplify it the grades are united into groups by division lines, which, however, are not at all drawn by each teacher according to his own opinion, but fixed by authority of the faculty of the university. The teacher now divides his list of a hundred students (whom, according to rank, he has graded himself, of course, since no one else can do this) into four groups of twenty-five students each, or, if the teacher prefers, an executive officer of the institution can divide them into these groups.

The students of the first group are marked E or S. Either of these "grades," therefore, does not stand for any degree of accomplishment as defined by anybody, but stands for the numbers from 1 to 25. The faculty has not yet drawn the division line between those of the twenty-five to be marked E and those to be marked S. But the actual practise of two sessions has been to mark the first four E and the following twenty-one S. The following two quarters of the list are marked M. This is prescribed by the rule of the faculty and leaves the teacher no choice. The last twenty-five are again divided into two groups called I and F.

The faculty has again left it, at present, to the discretion of the teacher to draw this division line. But actual practise has shown itself in favor of separating the last seven of these twenty-five as failures, and marking the eighteen students remaining above these seven as I.

Of course, a teacher does not, as a rule, have classes of just a hundred students. But he can distribute the five grades in the same way whatever the actual number of his students. Only in small classes there is this difficulty left that in any semester the membership may be unusually good or unusually bad. The teacher, therefore, is not expected at all to comply with the rule until, possibly after several semesters or even years, he has reported to the official recorder of grades several hundred grades. Then, sooner or later in the case of different individuals, the faculty calls him to account for what he has done. In Missouri the faculty has a special committee charged with this general supervision of the grading.

The system has now been in use for over two years. Considering all the grades reported during these four semesters and three summer sessions, we find that the highest four per cent. are excellent (E), the following twenty-one are superior (S), the following fifty-two are medium (M), the next sixteen are inferior (I) and the last seven have failed (F), not taking into account decimals. The only deviation from the rule, then, consists in this that two of the eighteen students of the I class have been marked one step too high, as M. Such an amount of regularity in general was perhaps to be expected. More interesting is the variation of marking found among the individual teachers.

In order to compare the individual teachers, let us represent graphically the marking by them of those students who according to the rule ought to be marked M and who are just one half of the total number, having twenty-five per cent. above them and twenty-five below. Each of the seventy-two rectangles of the diagram of Fig. 1 represents by its horizontal extent these students. If every teacher

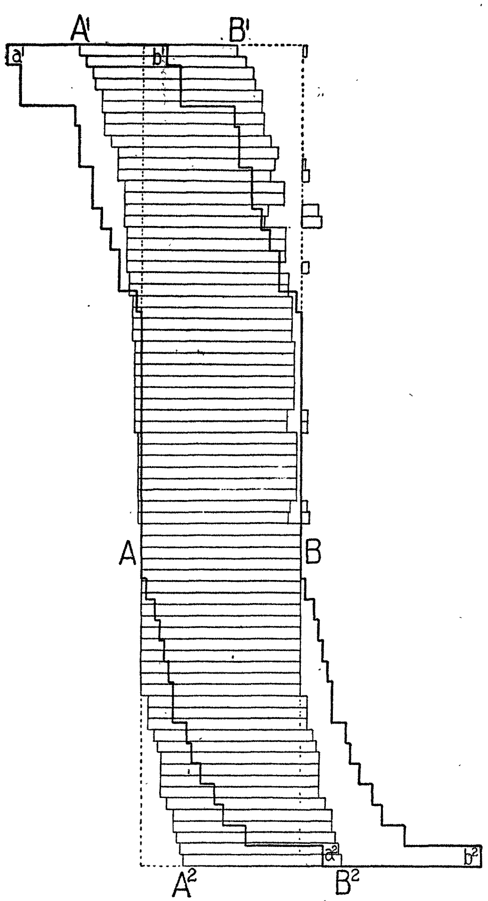

FIG. 1

had actually given all of these students the grade of M, these rectangles would lie exactly one over the other, forming the straight column indicated by the dotted lines. The greater the fraction of these M-students who have received from their teacher S instead of M, the more the particular rectangle reaches beyond the left border of the column. The most extreme case of this high grading is found above at A^1, B^1. Below where the rectangles reach beyond the right border of the column, we find those teachers represented who have given a fraction of their M-students the grade of I. The lack of uniformity may be measured by the ratio of the total area lying outside the column to that of the column itself. This ratio is about ten to a hundred, so that we may say that one tenth of the grades given are unjust in being either one grade too high or one grade too low.

The diagram which has just been explained represents the grading from the time of the introduction of the new system to the end of the first semester of the last session, that is, the grading of three semesters and two summer sessions. The last semester is not included because of a change made in the method of compiling the statistics. The diagram, further, represents only seventy-two teachers. Those who did not report, during the time mentioned, at least ninety grades, have been omitted. It would be unfair to include teachers who had so few students because in the case of these teachers the variations must be regarded as accidental. That the deviation from the standard amounts nevertheless to one tenth illustrates the great resistance with which the introduction of a new system of grading, the requirement of a new way of thinking, meets in a mind influenced by traditions of a different past. There seem to be still not a few teachers who report their E's, S's, etc., as if these grades represented well-defined or definable percentages of a maximum ideal accomplishment of "100" instead of rank. There seem to be others who only with difficulty get accustomed to the idea that we have now four passing grades, whereas formerly we had only three, and who on this account hesitate to assign the fourth grade, the I. However, that these deficiencies in the actual working of the system will speedily disappear seems to follow from the great progress already made, which becomes obvious when we compare the lack of uniformity under the present system of grading with that prevailing under the previous system.

In the same diagram the black lines represent in the same manner the grading by forty teachers of rather large numbers of B-students during five sessions of the university. The former passing grades were A, B and C, and these were assigned, on the average, to 24 per cent., 35 per cent. and 32 per cent. of the students. Since the B-group is the largest of these, it is best to use it for comparison with our present M-group. The diagram shows what fractions of the B-students were given the grade of A (at the top) or a grade lower than B (at the bottom of the diagram). The scale of drawing, for comparison's sake, has been adjusted so that the central column of this case is identical with the central column for the M-students of the present system. The diagram clearly shows that a large fraction of the B-students were formerly unjustly marked other than B, in figures, 24 per cent. of them. And worse than this, many students were graded two steps lower by one teacher than by another. For example, take a student in the center of a file of B-students. Under one teacher, at a^1, b^1, in the diagram, such a student standing just in the middle between a^1 and b^1 would invariably receive the grade of A. Under another teacher, a student of the same rank of scholarship, standing in the middle between a^2 and b^2, could not entertain the slightest hope of getting a higher grade than C. Moreover, the best of the B-students, at the point of a^2 in the diagram, would get no B under this teacher. Such enormities of divergence have forever disappeared since the introduction of the new system. Even the extreme cases of the M-students, A^1, B^1 and A^2, B^2, overlap to some extent. The ratio expressing the lack of uniformity in grading was twenty-four to a hundred as short a time as two years ago. It is now ten to a hundred. I am confident that it will still further decrease in the near future. The improvement already attained is really greater than it appears in the diagram, although it is there conspicuous enough. The teachers who varied so enormously under the old system were all teachers of very large classes, so that there was no possible excuse for this variation. I must point this out also for another reason. Professor Dearborn, in discussing our former variations, thought that they were probably to be explained by the fact that teachers of small and advanced classes had been included in the statistics. They were not.

I am sure that any institution can in the same way make its grading more and more uniform, but only under the condition that the faculty does not expect mere legislation to accomplish the desired result. Our experiences in Missouri prove conclusively that it is absolutely necessary for the faculty to have a special committee which collects each semester the cumulative results of the grading of each teacher and calls attention to those deviations from the rules which seem to be unwarranted. We publish each semester among the teachers of the university a statistical table showing how each teacher has thus far graded his students. I regard this publicity as essential to the success of our system. Besides this, our committee collects data as to the relative standing of special classes of students, for example, athletes, fraternities, women, freshmen, etc.

Although the method used by the individual teacher for ranking the members of his class is irrelevant to the system of grading under discussion, I wish to mention briefly the method used by myself because there is no end of complaint on the part of college teachers concerning the large amount of time which the teacher has to spend on examinations. I use almost exclusively the conjectural or completion method which was introduced into psychological science by the late Professor Ebbinghaus for the measurement of general intelligence, but can be used with equal success for the measurement of the student's rank in a class. The following is an example of an examination blank in which certain words have been omitted. The student must fill in the blank spaces in such a manner that the whole becomes meaningful.

The fact of *simultaneous* color induction is well illustrated by the *Hering* window. This consists of two narrow windows at some distance from each other. Any object then throws two shadows. one from each window. The one shadow coming from the colorless window ought to be simply *dark*, but appears, if the other window contains, say, red glass, of a saturated *red* color because at this shaded spot no *white* light is mixed with the *red* light. Everywhere else this mixed illumination takes place and makes the observer overlook the fact that the whole room with everything in it appears actually *reddish.* The other shadow, coming from the red window, might be expected to appear simply *white,* since this shaded spot is illuminated only by *white* light. As a matter of fact, it appears, by *induction, green* because the whole room excepting this spot stimulates on our retina the *red* process. The area on the retina corresponding to this shaded spot is therefore the only one where the disturbed *equilibrium* of the components of the *red-green* substance can be to some extent *restored* by spontaneous action of the sense organ. (Words in italics are blanks.)

The maximum number of points which any student could make in the quiz shown is fifteen. In case the word inserted was not quite correct, but indicative of the right approach to the solution of the problem, one half point was given. A class of twenty-six students made the number of points shown in the table below. Students having the same number of points were given precedence according to the order in which they had been able to hand over their quizzes to the instructor. Ranking these papers took about thirty minutes, and having completed the task the instructor felt sure that he had done no appreciable injustice to any of the students. Ranking twenty-six different essays on the same subject, the Hering window, would have taken several hours, and the instructor would have finished his task with the unpleasant conviction that his ranking in many cases was arbitrary.

	Points		Points		Points
1	15	10	12½	19	5½
2	15	11	12½	20	5½
3	14½	12	12	21	5½
4	14½	13	11½	22	5½
5	14	14	10	23	5
6	13½	15	8½	24	4½
7	13	16	7	25	4½
8	13	17	6	26	2½
9	12½	18	6		

I do not record the number of points made in any quiz by any student, but only his rank, placing those who "cut" at the bottom of the class. I find that this is an excellent way of insuring class attendance. At the end of the semester I sum up the rank numbers of each student and, by the smallness of the total, determine the rank for the whole semester. By recording in each quiz, not the points made, but only the rank, we overcome the difficulties in grading caused by the fact that examinations are sometimes too easy, sometimes too hard. In either case the best students come out on top, the poor students at the bottom, especially when we take into account, as mentioned above, the time within which each student completed his task.

Let us take up another problem, which, it seems to me, is dependent on our system of grading, but which is by no means a part of this or any system of grading. I believe that Professor Cattell was the first to point out the justice of giving more credit towards graduation to those students who ranked high in scholarship than to those who ranked low. Now, the first and absolute condition of giving varying credit is a method of controlling the uniformity of grading in the institution. Without this the injustice done by diversity of grading on the part of different instructors is only multiplied. In the University of Missouri we credit an E with 30 per cent. plus, an S with 15 per cent. plus, an M with the normal credit, an I with 20 per cent. minus and an F with nothing. It must be understood that the choice of these quantities is for the most part experimental. We are gathering data to put our credits on a more strictly scientific basis.

I have heard of only one real argument questioning the justice of varying credit. Some believe that by letting a student of excellent scholarship graduate after having taken a somewhat smaller variety of courses than the average student, we give the degree to one who does not have the breadth of training which a college graduate ought to possess. I must say that, judging from my own experience with students, this argument is a fallacious one. I have never had an excellent student in psychology who did not have a good knowledge in languages, in history, in biology, etc. Indeed, I am inclined to assert that his knowledge of these other sciences, his comprehension of the relation existing between psychology and these other sciences, made him an excellent student in psychology. And this, I think, holds good also for other studies, more or less. I therefore believe in varying credit. We ought not to make conditions in college unnecessarily different from conditions in life. In life too our credits vary.

The amount of credit which we give for different scholarly accomplishments depends on our view as to what is the distribution of such accomplishments in a large number of students. The division lines which we draw between the different grades, as explained above, also depend on our assumption of a definite curve of distribution. I am inclined to think that, owing to the insufficient data which we possess at present, we have to base our conclusions on the normal curve. Three years ago I had the honor of speaking on this very question before this section of the American Association. I then criticized certain conclusions drawn by Professor Hall. Since my criticism has been slightly misunderstood, I wish to repeat what I wanted to point out. I did not want to belittle Professor Hall's work on the distribution of scholarly abilities. But I held, and still hold, that Professor Hall found his students distributed in accordance with the normal curve simply because he believed, while he was teaching and examining these students, that they ought to be distributed thus. I shall try to make this clearer.

Fig. 2 shows two entirely different curves of distribution. You may be surprised that these are the same students in the same subject. The only difference is that the broken lines represent the outcome of a very difficult examination, requiring a large amount of reasoning; the continuous lines represent the outcome of an examination of the kind most commonly given by instructors, which enables most of the students to respond to a majority of the points correctly, especially when there

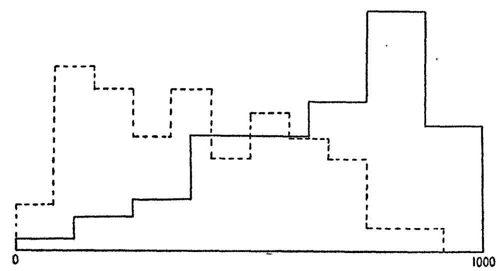

Fig. 2

is no time limit, or when the time of completing the task—of such enormous significance in life—is not taken into account at all. College teachers usually assert that the curve of distribution is not the normal curve, but a skewed curve like that of the continuous lines. They are usually ready to explain this by referring to the elimination of poor scholars in the high schools and lower schools. I have considerable doubts as to this elimination. Is the work done in a high school really so much like that done in college that there is a large previous elimination of poor college students? Our curves clearly show that the skewed distribution which an instructor finds is likely to be simply the result of the kind of examination which he gives. If he believes that the distribution ought to be like the curve of the continuous lines, he will give his examinations accordingly. If he believes otherwise, he will give his examinations otherwise.

I do not admit, then, that anybody has proved thus far that the distribution of scholarly accomplishments in college is like the normal curve or like a curve skewed either way. Under these circumstances, if for any purpose we have to assume, at least provisionally, a particular distribution, I see no other possibility than that of regarding scholarly accomplishments as based on biological properties and assuming the normal curve as the most probable one.

All this, however, does in no way interfere with our actual practise of grading. Our division lines between the different grades may be drawn somewhat arbitrarily, the relative credit given for the different grades may be somewhat arbitrary, the injustice done the students under a system which enforces uniformity of grading is nevertheless small compared with the injustice when each instructor is left to grade according to his own fancy.

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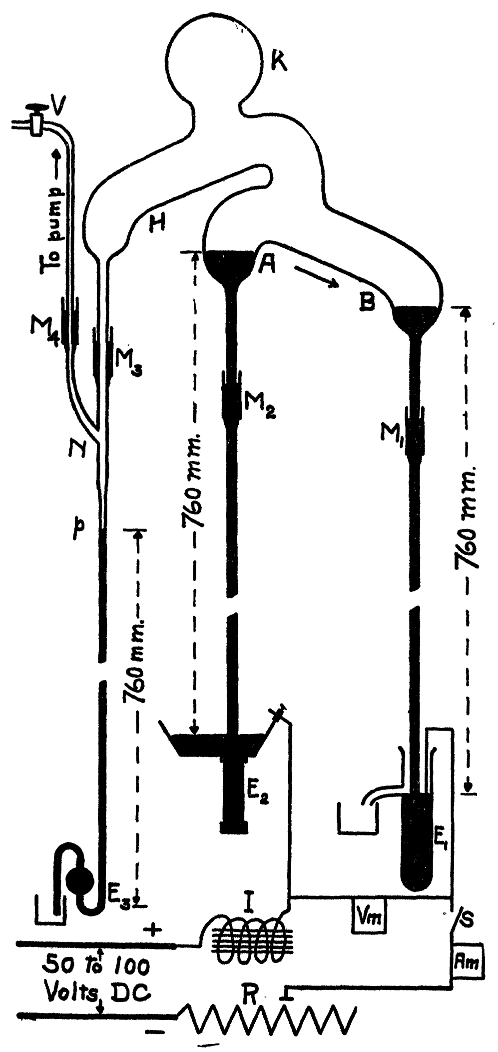
AN EFFICIENT AND RAPID MERCURY STILL

IT is with some hesitancy that the writer attempts a description of so simple and commonplace an apparatus as a mercury still. Nearly every laboratory has its own method of purifying mercury. However, of the various "dry" methods that are usually employed two stand out prominently—Weinhold's method and Hulett's method.[1] The principle of the first is to distil under reduced pressure or partial vacuum; while the second in addition to this makes use of a small jet of air bubbling up through the mass of mercury. The jet of air plays the rôle of oxidizing the metallic impurities. Both methods are good. The purifying effect of air bubbling through mercury, even at room temperature, is now well recognized.

In 1905 the writer described a new form of still,[2] in a brief paper read before the American Association for the Advancement of Science, at its New Orleans meeting, in which use was made of the mercury vapor lamp. A description of the apparatus[3] as at present modified and perfected by several years' use in the laboratory is the object of this paper.

It is common observation that mercury condenses on the walls at the cooler parts of the lamp. Now by fusing to the mercury vapor lamp a properly shaped condensing chamber, mercury of a high degree of purity may be obtained. For the apparatus to be a practical working still the lamp must have additional modifications. Fig. 1 shows all of the essential parts. The mercury arc is maintained between the electrodes A and B. These electrodes are of mercury and are in communication, through the narrow barometric legs BE_1 and AE_2, with the vessels E_1 and E_2 containing the supply mercury. These vessels are connected directly through an adjustable resistance and an inductance to some convenient source of direct current. It is well to include



[1] Hulett, *Phys. Rev.*, Vol. XXI., December, 1905.

[2] SCIENCE, Vol. XXIII., March 16, 1906.

[3] Letters Patent, U. S. A., Nos. 891,264, 891,265; Germany, No. 201,017.