

until other mark cuts arc. Designate these points, respectively, F and E, thus making $EF = DB$. Draw BE.

Then $\angle EBF = \frac{1}{3}\angle ABC$.

PROOF.

In Fig. 1:

$\angle EFB = \angle EBF = \frac{1}{2}\angle BED = \frac{1}{2}\angle BDE$,
or $\angle BDE = 2\angle EFB$.

$\angle EFB + \angle BDE = \angle DBH$.

Substituting $2\angle EFB$ for $\angle BDE$,

$\angle EFB + 2\angle EFB = 3\angle EFB = \angle DBH$.

$\therefore \angle EFB = \frac{1}{3}\angle DBH$.

But $\angle DBH = \angle ABC$ by construction and $\angle EFB = \angle EBF$,

\therefore by substitution $\angle EBF = \frac{1}{3}\angle ABC$.

In Fig. 2:

When D lies between E and F substitute BED' for BED and BDF for BDE and proceed with $\angle EFB = \angle EBF = \frac{1}{2}\angle BED' = \frac{1}{2}\angle BDF$ etc.

For angles greater than 180° bisect and proceed with either half, so that the remaining two thirds of the half angle is adjacent to the side of the angle.

THE NEW ENTRANCE REQUIREMENT IN CHEMISTRY AT MASSACHUSETTS INSTITUTE OF TECHNOLOGY.¹

BY ARTHUR A. BLANCHARD.

The purpose of the entrance requirement is not to make more advanced work in the college course possible; it is to establish a coordination of the high school and institute courses so that the latter may follow the former without discontinuity and without the sort of repetition that is demoralizing. It is of the spirit in which we hope that this coordination may be accomplished that I wish to speak.

Up to the present it has been an unsolvable problem at the institute how to give any adequate recognition to the excellent training some of our students have had at high school and still treat fairly those students who have had no previous chemistry. That the instruction in the high schools is good is evidenced by the one or two young men who almost every September take and pass with a very high rating our entrance examination for advanced standing in chemistry. Perhaps they have had more than one year of high school chemistry. These men are admitted at

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once to our second year courses in chemistry and there do credit to their earlier training. But it is only the very exceptional young man who has thus drawn the full amount of benefit from his high school training. The average good student would be hopelessly lost were he to try to enter such an advanced course. It is to the average good student that this discussion is devoted.

But the average good student feels aggrieved and loses interest if he is mixed with others with no previous chemistry, and has to repeat the drill in simple conceptions which he feels he already understands.

Although a student may have forgotten his chemistry during the summer so that he could never pass an examination, nevertheless it is astonishing how the background of chemistry he has acquired helps him to comprehend what we have to offer him. Science demands a continued repetition of basic principles applying them ever to new knowledge and to more complicated cases. Although the student may balk at repetition of the principle in the same old setting, he becomes interested when he sees that principle being put into difficult and embarrassing situations and changing confusion into understanding. It makes him want to get a better acquaintance with the principle and willing even to go back and review if need be the principle in its simplest aspects.

The institute hesitated for long before putting an added burden on the high schools. A year ago last spring Professor Phelan sent a circular letter to the schools requesting opinions upon the subject and the replies showed a practically unanimous agreement that such an entrance requirement as he proposed would entail no hardship on the schools. For such candidates as come to us without having fulfilled the entrance requirement, the Institute now offers an entrance course beginning in the latter part of August and lasting five weeks.

We think that our entrance requirement in chemistry is unique in that no examination is required, simply a certificate that the student has taken a course of at least 150 hours and has shown diligence and reasonable intelligence.

We have no desire for the schools to establish special courses in college entrance chemistry and cram the pupils to pass an examination upon topics in a college entrance syllabus. In fact, we feel in many ways it is an advantage for the pupil to study chemistry in the class that ends its schooling with the high school.

School boards and parents are prone to demand practical usefulness from science courses. Teach the child something that will enable him to earn money or to save money, or to avoid sickness. The teacher knows the limitations to the usefulness of mere practical information, uncorrelated by general principles, but the teacher doesn't tell the school committee or the parent that it can't be done; he cheerfully tells them he will teach the chemistry of bread making, or of combustion, or of physiology, or of coloring, or of metals, or building materials, or what not, and he goes ahead and teaches fundamental principles, emphasizing every point of contact with practical daily life. Thus we at the institute are sure to be satisfied if the pupil has the background of 150 hours training with a capable teacher whatever special emphasis may have been given the course.

I have anticipated I might be asked what particular topics in chemistry we should assume the pupil to know before starting with us and the list I shall give will not be long. It is as follows:

Pure Substance and how to recognize it.

Element.

Compound.

Law of definite proportions.

Atomic weights.

Familiarity with the more characteristic properties of oxygen, hydrogen, chlorine, nitrogen, argon, sulphur, sodium, calcium, magnesium, copper, aluminum, iron, lead, silver, gold.

The essential difference between a metal and a non-metal.

Acids, bases, neutralization.

The law of combining volumes of gases.

Symbols and formulas.

Chemical equations and their interpretation.

Exothermic reactions: combustion and liberation of energy.

Such a list of topics has about as much meaning as a bill of fare. An extensive and flowery bill of fare at a cheap eating house does not mean much. But a plain bill of fare at a hotel of high reputation means satisfaction.

This bill of fare is couched in simple English and the seasonings and garnishings are not even mentioned, much less enumerated with French names. Knowing the reputation of the schools and teachers who are to serve it we are confident that the meal will be good, that the substantial courses will be seasoned and palatable; and that parsley, pickles, olives, celery, bonbons, nuts, whatever garnishings are suitable, will appear at the proper places to make the meal attractive as well as nutritious.

We trust to the skill and discretion of the cook in preparing a meal; we might even with safety leave the bill of fare to the competent cook. Likewise we leave the course in chemistry to the

competent teacher, knowing that although the topics mentioned suggest and involve other topics, not mentioned, and in fact if pursued exhaustively would embrace the entire realm of science, the teacher will treat these topics with discretion and make each one of them present some clear and tangible, yet simple, conception to the student's mind.

Finally, I might state again the things we do not want, and the things we do expect to gain from this entrance requirement. We do not want a prescribed course in high school which will take up certain things and abstain from all others and will stop at a definite point, from which point we are to start with machine-like precision. Such an accomplishment would be impossible to bring about anyway, but, were it possible, we would not want it.

What we do expect is to gain for our students a background of experience—some acquaintance with common elements, their compounds and their reactions, and some appreciation of general principles through which chemical knowledge is correlated, but most of all an interest in chemistry and an eagerness for more knowledge and more understanding of this subject. We feel very confident that the high school teacher cannot help giving this desired background, whatever practical aspects of chemistry may have been accentuated in the course.

I was careful to emphasize that the list of topics, in one sense, meant nothing at all. It means no limitation upon the choice of the teacher because no topic is included which any teacher would even consider omitting from a 150-hour course. It is to be expected and hoped that the high school course will go outside this list. No industrial or practical topics are included because it is taken for granted that they will be used in varied ways to enrich any course. Neither are Avogadro's hypothesis, nor ionization included, but very few teachers will refrain from introducing them. These two topics are typical of a certain kind which must be taught thoroughly in college. I think that this will entail no burdensome repetition of what may have been taught in high school. Certainly these are topics which are capable of ever expanding applications even to the most advanced departments of chemistry.

And yet we are very confident that the background represented by the topics of our brief list will give what we need on which to build a college course which will hold the enthusiasm of the best students while it does not run beyond the comprehension of the average ones.