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The State Course of Study: Chemistry

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be removed without apparent loss to the individual. The cells of the cortex are almost countless; the possible synapses or connections between them are, according to one anatomist, greater than the number of atoms in the whole solar system. That we shall ever grasp the workings of such a maze of parts, seems improbable, but at present, at any rate, the mind, born of the brain, seems incapable of understanding the thing that produces it. Thus the plight of the biologist!

But the surprising thing about the whole matter is that in spite of the biologist's admitted shortcomings, the layman, overwhelmed, so to speak, by the omnipresent applications of physics and chemistry, has at once elevated him to coequal position with the physicist and the chemist. The biologist recognizes his own limitations but his public does not. He speaks of yeast, and straightway we have a shotgun panacea for all human ills—we become a nation of yeast-eaters over night. He discovers a virtue in orange juice, and though we may suspect the citrus fruitgrowers, we pour it down our children by the gallon, because a biologist has spoken! European opinion to the contrary, we Americans do earnestly what we do, especially in physical matters, and though we may privately dissent from the verdict of the biologist, we eat our spinach none the less fiercely. On every side of him, the biologist sees his fellows doing in the name of biological science, things which Biology has never demonstrated to be good for the race. Millions bathe with devout faith in its healthfulness, but science has never shown that a clean man is healthier than a dirty man—he is simply more tolerable aesthetically. Millions of others daub their skins with all manner of supposedly nutrient and healthful concoctions not knowing that the skin absorbs almost nothing externally. Hosts of others dose and coddle themselves throughout a hectic life, ignorant of the fact that health is largely automatic, that the only real way to insure a long and healthy life is to have chosen healthy and long-lived ancestors. And so on indefinitely. In the meantime, with a sad smile, partly at his own ignorance and false position, partly at the credulity of his fellows, the biologist keeps on working.

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THE STATE COURSE OF STUDY CHEMISTRY

The State Department of Public Instruction has recently completed a far-reaching and valuable contribution to the curriculums of our state system of schools. With the cooperation of many prominent educators of Iowa, courses of study for the grades and departmental courses for the High Schools have been carefully prepared and made available to all teachers. Among these outlines is one for chemistry teachers. According to policy, these course outlines are distributed gratis to the school and become the property of the district.

The Chemistry Course of Study does not limit the teacher to a prescribed course. Neither does it designate a definite order of topics nor method of presentation. It is applicable to any textbook and lends itself to great flexibility in pedagogic methods. To offset any personal preferences of the committee, the periodic system of elements forms the general basis for order of topics. The theory chapters are fitted in where they seem best to correlate. The arrangement of material follows the four column plan used in all of the state syllabi.

In the first column are listed the objectives which the teacher should establish before presenting the topic. As a result of many questions directed to his classes in the Teaching of Chemistry, the writer has learned that a group of experienced and prospective teachers may differ widely in the objectives which they would assign to a given topic. Some overlook major ideas and attach undue importance to incidental points growing out of the topic; others establish such all-inclusive objectives as to offer unlimited latitude in class presentation; still others will list so large a number that it would seem they are unable to winnow the wheat from the chaff; and a fourth group can

see no need of any objective except the chapter title. Before an architect plans a building, he must know its size, purpose, construction materials, and approximate cost. On the one hand, he must not simply be directed to plan a building; on the other hand, he is not instructed as to number of doors or location of electric switches—details that are settled as the drawings progress. When teaching oxygen, it is not sufficient to place as the one objective, "to obtain a knowledge of oxygen" nor should such detailed objectives as "effect of oxygen on iron" be included. The latter will appear under the general objective of "properties". It will be noted that the "objectives" are presented from the viewpoint of the pupil—not "to teach" but "to learn". If the teacher will view his methods and subject matter from the pupils' side of the desk, he will be far more successful in "getting it across."

Let us examine three illustrative cases. Oxygen is a substance of daily experience. It also introduces the pupil to his first study of a chemical substance. Hence no less than five major objectives covering three pages are assigned to it. They include its occurrence, its preparation, its properties, its uses and related ideas. No shorter a presentation would introduce the pupils to the great world of chemical substances and their most representative citizen. Again, sulfur is a less important element; it presents no new basic principles; it is but another member of a now familiar chemical world. Hence its study can be dismissed with a scant inch in the Outline. Theoretical chapters offer the greatest difficulty in their objectives. What facts should precede them? How fully should they be discussed? What line of approach and reasoning should be employed? If we could all agree on the answers, objectives would be much simplified. Our third illustration deals with the theory of ionization. It is developed on three presumptions: that acids, bases and salts have been presented, that atomic structure is for later study, and that theory is to be studied as a tool and not an end in itself. Hence its objectives are only two-fold: an approach through electrical conductivity and its phenomena and applications.

The second column in the Chemistry Outline is concerned with "Teacher Procedure" in relation to the objectives. It offers, shall we say, a directive motivation for the teacher. It helps to answer the question, "What shall I teach and in what order?" Yet to depart from the procedure order is not heresy. The writer sometimes first calls attention to some common uses of a substance in order to develop a lively interest in the topic. The teacher is encouraged to assign outside readings, to employ lecture experiments, to utilize charts and displays, to refer to general and industrial applications, and to use commercial exhibits and films wherever feasible.

"Pupil Activities", presented in the third column, are necessarily subject to the school equipment, to the manual used, and to local industries. Certain laboratory experiments are well-nigh standard and universal. These include preparations, properties and tests. But laboratory monotony and class room apathy must be avoided. The secret is "variety". To illustrate, ammonia is commonly made in the laboratory from an ammonium salt and a base and its odor, color, density, solubility and action with hydrogen chloride are noted. Not very thrilling! How different the result if the teacher, following the Outline, relates ammonia to gelatine, coal distillation, atmospheric fixation and reference book and magazine articles. To the teacher whose conception of pupil activities in chemistry is confined to the treadmill, question-and-answer types, the "activities" column is a veritable gold mine and to his pupils it means a release from prison lockstep.

When the pupil leaves the halls of learning he forthwith proceeds to forget his "lessons" as rapidly as possible and often with phenomenal success. Mere facts are apparently lost, though really only mentally filed for later use; but habits, impressions and ideals often stick like the proverbial burr. In the fourth column, "Evidences of Mastery" are classified as "direct" and "indirect". Under the former is listed the factual

knowledge of the topic which, during its study, should be rated as of major importance. The latter suggests a sugar-coated pill. The pupil is hardly conscious that he is acquiring the knowledge, habits and skills with which this great science is so ably fitted to endow him. Yet the skilful teacher, who appreciates and applies his opportunity, will find not only an immediate response to his teaching in the direct evidences of mastery but an indefinable, immeasurable, permanent benefit as measured by the indirect evidences.

Additional help is offered the teacher in the Appendix, some part of which will be of value in every Chemistry course. This section includes, topics for supplementary study and reports, general experiments, extra experiments, lists of supplies for the pupil's desk and the stock room, and a bibliography of high school texts and manuals, general references, encyclopedias, popular books, books on testing and on teaching. Such lists are not necessarily complete, but are suggestive.

The authors made no claim to infallibility, but they did their best in the time allotted; column headings have been exchanged on some pages, but on the whole the book is well arranged and neatly printed. The real test of the value of the State Chemistry Course of Study for High Schools must be delegated to the high school Chemistry teachers of Iowa. You are cordially invited and urged to study it consistently, to use it intelligently and to criticise it constructively.

R. W. Getchell.

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GENERAL SCIENCE

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Parsons, Hodgdon, Washburne and Caldwell, and Eickenberg. The average per cent of physics and chemistry in these texts was 51.1%. Including astronomy, which is also physics, the percentage was 54.5%. The average per cent of natural sciences inculding entomology, zoology, botany and geology was 10%. The remaining part of the texts is made up of such miscellaneous subjects as hygiene, bacteriology, agriculture, home economics, and sometimes a few pages of meteorology.

In the light of the above analysis what would make a good preparation for the teaching of general science? In the first place, it is evident that the teacher should have a good foundation in general physics from a college view point. He should also be versed in the elements of general chemistry covering the division of metals and non-metals. Next to these two sciences and of equal importance with either comes naturally elementary biology. The biological outlook should carry proper laboratory experience with it.

Now to the odds and ends. As the above would probably cover only two-thirds to three-fourths of the necessary preparation for efficient general science teaching, the next essential for a general science teacher would be some knowledge of geology and mineralogy. A thorough knowledge of what is given in Chapter IX of Brownell's Physical Science published by McGraw-Hill Book Company, would be abundant. Besides this geology, there should be a clear understanding of the make-up of the solar system and a knowledge of the most important general facts about the stars in the heavens. The teacher could use a bit of star gazing profitably in his teaching providing he is familiar with some of the principal constellations, viz., Ursa Major, Ursa Minor, Orion, Cepheus, Cassiopeia, and especially with the signs of the zodiac.

With these two minor subjects of astronomy and geology we should include, of course, some knowledge of elementary systematic botany and zoology besides a little of meteorology and bacteriology. These minor subjects could be mastered, and afterwards extended, from reading what is given in several of the best tests on general science designed for ninth grade work. The main thing is to understand thoroughly the elements of physics, chemistry and biology, the three foundation lines of science.

L. Begeman.