LABORATORY STUDIES IN CHEMISTRY

Published @ 2017 Trieste Publishing Pty Ltd

ISBN 9780649525829

Laboratory Studies in Chemistry by Robert H. Bradbury

Edited by Trieste Publishing Pty Ltd.
Cover @ 2017

www.triestepublishing.com

ROBERT H. BRADBURY

LABORATORY STUDIES IN CHEMISTRY

Trieste

TWENTIETH CENTURY TEXT-BOOKS

TWENTIETH CENTURY TEXT-BOOKS

LABORATORY STUDIES IN CHEMISTRY

BY

ROBERT H. BRADBURY, A.M., PH.D.

HEAD OF THE DEPARTMENT OF SCIENCE IN THE SOUTHERN HIGH SCHOOL, PHILADELPHIA

D. APPLETON AND COMPANY

NEW YORK CHICAGO

PREFACE

Briefly stated, the main features of this laboratory manual are as follows: —

1. It covers thoroughly the various syllabi which teachers preparing students for college have to consider.

2. Each exercise, including the writing of the notes, can be finished within ninety minutes.

3. The apparatus required is simple and inexpensive, and due regard has been given to the prices of the chemicals. Expensive substances are employed at times, but only in very small quantities.

4. The fact has not been overlooked that the teacher of science usually carries as many hours on the roster as the teacher who has no apparatus or materials to arrange. I have tried to simplify the manual labor required of the teacher, without reducing the efficiency of the work.

5. The experienced teacher will at once perceive that the practical details of the experiments have been worked out with unusual care. It has, in fact, taken me many years to get these laboratory studies into the shape in which they are here presented, and I have refrained from publishing them until I had made sure that they were as perfect as the painstaking labor of my students and myself could make them. I shall be very grateful indeed for any suggestions as to further improvements from other teachers.

It is, of course, as impossible as it is undesirable to frame a set of directions which shall be a substitute for the teacher. What I have tried to do is merely to save the appalling waste of energy involved in the constant repetition of details such

as quantity needed, vessel to use, height of flame, dilution, etc. To supply this sort of information is precisely the function of the laboratory manual.

6. It is not at all difficult, at present, to put together a set of exercises which will occupy the laboratory time of the beginner for a year in a pleasant and orderly way. It is less easy to make sure that each experiment is significant and worth while, that it adds something to the logical development of the student's ideas and to his appreciation of the general points of view of the science. I confess that much that is offered under the caption of laboratory work seems to me hardly worth the time it takes. The student who comes to the laboratory might otherwise be doing serious work of permanent value in languages or in mathematics. His time should not be wasted with purely spectacular and pyrotechnic experiments, or with so-called quantitative studies, — like the heating of magnesium powder — in which even the most finished experimental technique must fail to secure reasonably exact results.

One of the chief devices I have employed in attempting to give greater educational value to the work is *classification*. For instance, the facts which relate to some central topic such as the action of soluble hydroxides on salt solutions, or the effect of heat upon carbonates, are not scattered through the book in a wholly aimless way: they are organized into a compact laboratory exercise which serves, once for all, to make the matter clear. Examples of this general principle of arrangement will be found in the exercises numbered 14, 22, 31, 37, 58, 59, and others.

7. Probably all teachers agree, nowadays, that some of the work should be *quantitative*. The quantitative experiments in this book have been worked out with the utmost care. Since I have, in my notebooks, upwards of a thousand results for each of them, I may fairly say that they are quite within the capacity of high school students, who, in fact,

work them out with enthusiastic interest. Naturally, the effect in improving the manipulative technique of the students is very marked. Far more important is the reality which is given to their conceptions of the foundations of the science. It is almost impossible to teach quantitative ideas without quantitative experimentation to give substance to the teaching.

A balance sensitive to a milligram can now be bought for about ten dollars. Small weights, which may be lost from the set, can be easily and cheaply replaced by cut lengths of No. 36 German silver wire, B. & S. gauge, one centimeter of which weighs almost exactly one milligram. The rest of the apparatus required is of the simplest description.

8. The literature of the elementary laboratory is now quite extensive, and I have tried to make a careful survey of it. Among the books which have been most helpful are Stoddard's *Quantitative Experiments in General Chemistry*, Karl Scheid's *Praktischer Unterricht in Chemie*, Ohmann's *Chemie*, and the Laboratory Manual of Alexander Smith.

The quantity of material required in the experiments is, in all cases, stated in a precise numerical way. These statements are intended simply to give the student a good *approximate idea* of the amount he should take. It is only in the *quantitative* exercises that the quantity stated should be accurately weighed or measured. The apparatus and materials needed are stated at the beginning of each exercise. Supplies always on the student's table, such as the burner, the stand, and the ordinary acids, are omitted.

A lead disk about 6 × 2 cm., pierced radially and axially is convenient for collecting gases over water. It is used in an agate pan, the bottle of water being inverted over the central perforation. The disk also has been omitted from the lists of necessary supplies, since there are many other devices which may serve the purpose equally well.

It may not be amiss to call the attention of teachers to the use of potassium permanganate, instead of manganese dioxide,

for generating chlorine, and of formic acid, instead of oxalic acid, in the preparation of carbon monoxide. In both cases, the older methods have been obsolete among chemists for some years, and one cannot help wondering at the misplaced conservatism which causes their continued republication in the newer elementary texts.

It is not improbable that chemists who are not engaged in secondary teaching may be surprised at the care which has been taken to exclude complex and expensive apparatus. Let me add, therefore, that the secondary school teacher handles sections of thirty or more without laboratory assistance and without time for preparation, that he must finish his exercise in a definite time, which is usually not greater than ninety minutes, and that his students have had no opportunity to acquire manipulative skill. When these conditions are generally understood, a certain amount of energy, which is now wasted in rather futile criticism of secondary aims and methods, will be expended in some more useful way. In fact, to do the best that can be done under these circumstances forms a difficult problem, which is quite different from the problem of the college or university instructor. To offer, in a small way, some help toward the solution of the problem of elementary teaching is the object of the present book.

Professor Alfred L. Carey of the Southern High School has assisted me with the reading of the proof. The illustrations are from original drawings made by my wife.

ROBERT H. BRADBURY.

CONTENTS